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ABSTRACT

This teaching guide is a handbook for teachers using instructional television as part of an elementary school science program. The handbook deals with the how and why aspects of contemporary science education. It includes a growing set of primary and intermediate grade science lessons. Each lesson consists of science activities suited for two to five class sessions. The program is planned to help elementary teachers: (1) modify an on-going science curriculum, or (2) choose more wisely from available elementary science programs, or (3) develop a better science curriculum of their own design. The science lessons are directed toward concepts in the physical sciences. This guide provides instructional objectives, background information, and necessary equipment for each lesson. Teaching strategies and suggested time allotment for each lesson are also included. (EB)

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Science for the Seventies

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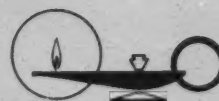
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ITV - Handbook for Teachers



Pennsylvania Department of Education 1973

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Produced by the
College of Education
and the
Division of Broadcasting
and
Continuing Education
of The Pennsylvania State University
for the
Pennsylvania Department of Education
with Funds Provided
by the Pennsylvania General Assembly

FORWARD

This booklet is designed as a handbook to help teachers use the ten televised SFTS programs as an integral part of the related lessons from Science For The Seventies resource materials developed by the Pennsylvania Department of Education.

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Back Cover: SFTS-ITV Song

SCIENCE FOR THE SEVENTIES

INSTRUCTIONAL TELEVISION



THREE LINKS in a chain
through which TEACHER and
CHILDREN become involved
in SCIENCE INVESTIGATION

INTRODUCTION TO
SCIENCE FOR THE SEVENTIES
INSTRUCTIONAL TELEVISION

CHILDREN

P.D.E.
ELEMENTARY SCIENCE PUBLICATIONS

TEN TELEVISION PROGRAMS

TEACHERS' HANDBOOK

SIX TEACHING STRATEGIES

PRIMARY TEACHER

- Reflects contemporary
LEARNING GOALS for
young children
- CONSISTENT with contem-
porary thinking in
science education
- TESTED in elementary
school classrooms
- INTEGRAL part of PDE
publications designed
to help teachers choose
and/or use existing
science programs

SFTS-ITV

IS *DIFFERENT*!!

SFTS-ITV programs cannot stand alone. Each is designed as a springboard for a specific lesson from the PDE publication *SCIENCE FOR THE SEVENTIES*.

YOUR CHILDREN
are part of it.

There are brief periods of silence in the programs where teacher leads children in discussion or simple activities.



SFTS-ITV is built on a "strategy teaching" rationale. Each program demonstrates one or more of six basic teaching strategies considered to be central to good science instruction.



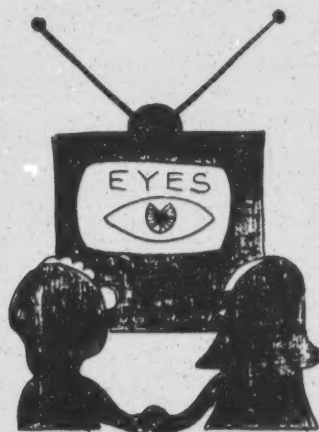
PENNSYLVANIA DEPARTMENT OF EDUCATION
ELEMENTARY SCIENCE PUBLICATIONS

Science for the Seventies is a set of instructional materials for Pennsylvania's elementary teachers. SFTS consists of:

- a) A Teachers Handbook dealing with how and why aspects of contemporary science education;
- b) A growing set of primary and intermediate grade science lessons - Each lesson consists of science activities suited for two to five class sessions.

SFTS is produced by a representative committee of Pennsylvania educators and published under the auspices of P.D.E. SFTS materials are available free from Dr. Irvin Edgar, Chief of the Division of Science and Technology, Pennsylvania Department of Education, Bureau of General and Academic Education, Box 911, Room 566, Harrisburg, Pa., 17126.

SFTS is planned to help elementary teachers: 1) modify an on-going science curriculum, OR 2) choose more wisely from available elementary science programs, OR 3) develop a better science curriculum of their own design.



SFTS TELEVISION PROGRAMS

Ten 15-minute televised science programs -

- geared to primary grades
- tested in classroom
- designed as springboard to effective science teaching
- planned to help teachers analyze and practice important teaching strategies
- Mystery Boxes
- Salt and Water
- Measurement
- Dripping Faucet
- Drops
- Siphons
- Observation and Description
- Thermometer
- Eyes
- Reflection of Light Beams

The SFTS-ITV programs are unique -

- The teacher and children are part of the program. At intervals during the program a question is asked by the TV narrator and a period of silence follows. Children viewing TV can then think, observe, respond - sometimes they actually do something. The teacher guides student interaction, usually by pertinent questions or comments based on one of six teaching techniques.



SFTS-ITV TEACHERS HANDBOOK

- Each of the ten SFTS-ITV programs introduces one of PDE's primary grade science lessons. The handbook includes a copy of the complete PDE lesson.

- An orientation to the ITV program provides a summary of important instructional purposes -

Discussion Period		INVESTIGATING MYSTERY BOXES		Teaching Strategy
9	TV Image	Final Broadcast Statement	Suggested Statements or Questions	
	Child tilting box	What do the sounds tell you about what is in the box?	What do you believe is in the box? Why did you make that choice?	

TEACHER-CHILDREN-TV

- The guide suggests the kinds of Statements and Questions the teacher might use to help children interact purposefully with the TV program during the Discussion Periods.
- At least one of the six Teaching Strategies will be identified as the rationale for each discussion period.

BEFORE



the SFTS-ITV program, you, the teacher should -

- Examine PDE's complete SFTS lesson introduced by the television program.
- Examine the SFTS-ITV teacher's guide to the program:
 1. to see the relationship between the ITV program and the SFTS lesson that follows
 2. to prepare for your role during the ITV program.
- Collect the simple teaching materials you will need in the follow-up SFTS lessons.
- Prepare to teach the first science activity from the SFTS lesson

EITHER

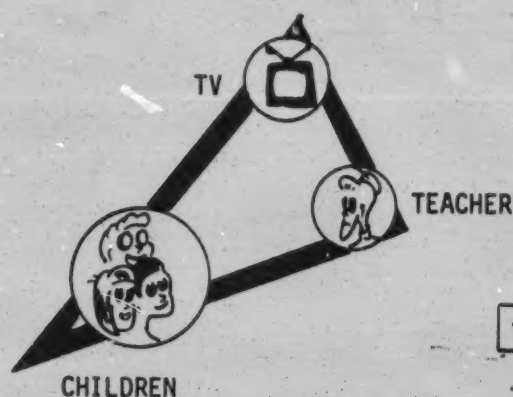
- immediately following the TV program

OR

- the next day.

DURING

The SFTS Programs



the CHILDREN

- SEATED informally so they can easily view TV screen
- FEELING FREE to
- respond to questions asked during TV program
- react to observations on the TV screen
- do simple science activities - if suggested by TV program

the TEACHER

- LOCATED so as to view both TV screen and children
- EQUIPPED with teacher's guide or notes
- READY
- to ask appropriate questions
- to analyze teaching techniques
- to make mental or written notes for follow up SFTS activities

AFTER the SFTS-ITV

program, the teacher should

- Respond to any immediate, spontaneous, relevant questions or comments from children. For some of these it may be appropriate to simply state that coming lessons will relate to an interest or concern expressed.
- When time permits, make notes for any modifications in the SFTS lessons which might have been indicated by the children's responses during the program.
- Teach the related SFTS lesson, scheduling the various activities according to professional judgment. Ordinarily the activities in the SFTS lesson should be scheduled so as to be completed within a week.

NOTE:

You, the teacher, should feel free to modify the SFTS lessons according to your professional judgment.



Science for the Seventies is Pennsylvania's guide for Elementary Science, published by the Pennsylvania Department of Education. The teachers guide and (10) lessons were published in 1970. Additional lessons have been published as they have been developed.

THE TEACHERS GUIDE

Table of Contents

What is SFTS

Why Science for the Seventies

Aims for Elementary Science

A Continuum for Science Education

The Learning Environment

Education in the Outdoor Environment

Evaluation in Science

Equipment for Elementary Science

The Relation of Textbooks to SFTS

SFTS LESSONS

Primary

Investigating Seeds and Fruits

Investigating Flowers and Fruits (Upper)

Investigating Static Electricity

Investigating Observation and Description

Investigating Magnets

Investigating Siphons

Investigating Dripping Faucet II (Upper)

Investigating Wheels and Gears

Investigating Eyes

Investigating Drops

Investigating Reflection of Light Beams

Investigating Mystery Boxes

Investigating Thermometer (Lower)

Investigating Dripping Faucet I (Lower)

Investigating Salt and Water

Intermediate

Investigating Splashes

Investigating Drop Designs

Investigating Astronomy

Investigating Liquid Surfaces in Containers

Investigating Bouncing Objects

MORE
about
SFTS

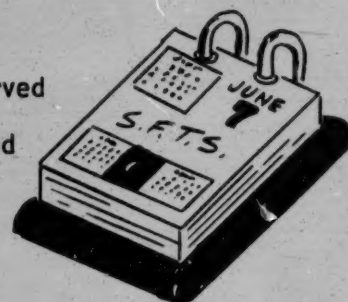


SFTS Programs Are Classroom Tested. Throughout the development of the SFTS-ITV programs the public school classroom has been our laboratory. Before the topics of the ten films were chosen, a broad selection of SFTS lessons were taught over a two-month period in eight first grade classrooms in the Penns Valley Schools in Centre County. Primary grade teachers were instrumental in the selection of science topics for filming and they were involved in decisions having to do with content, equipment and other professional concerns.



Based on experiences in the classroom, the ten ITV programs were selected, scripts written, and films produced. As each film was completed it was tested in 41 primary grade classrooms, via closed circuit television facilities in the Altoona School District. A working copy of the SFTS-ITV teaching guide was used by each primary grade teacher involved. A number of the ITV programs were also piloted as a part of two in-service programs in schools in the Harrisburg area.

During the ten-week pilot study, the ITV programs and the teacher's guide were evaluated by both subjective and objective means by the teachers. The pilot study evaluation served as a means of modifying the final copy of each film and the teacher's guide.



SFTS
TAKE #1

SFTS LESSONS - SOME CHARACTERISTICS

- emphasize direct involvement of children with materials
 - individual and group activities
- lessons identified as to appropriate maturity level
- needed equipment is easily available
 - can be found in many classrooms
 - or
 - can be brought in by children
 - or
 - can be purchased inexpensively locally
- little or no teacher science content background needed
- activities lead children to generally internalize and modify knowledge rather than acquire non-conceptual verbalizations
- do not require textbooks

SFTS is not a science program. It is a resource to help teachers:
experience interesting and worthwhile science investigation with children;
gain insight into contemporary thinking about elementary science instruction;
choose and use existing science programs;
develop local science curriculums.



SFTS is unique in its commitment to pupil growth in terms of long-term goals called AIMS.

SFTS AIMS

Each SFTS lesson incorporates opportunities for children to make progress toward the achievement of one or more of the SFTS Aims.

Cumulatively
Collectively - A science program consistent with the SFTS approach should develop competency in these - or similar - aims.

SFTS recommends that evaluation in elementary science should include evaluation of growth in terms of long-term goals such as the SFTS Aims.

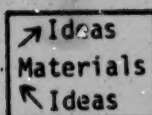
1. The student will measure with English units and metric units to solve problems concerning length, area, volume and weight.
 2. The student will formulate and ask questions of his environment as part of his efforts to describe, clarify, analyze problems and provide direction for problem solving.
 3. The student will solve problems by gathering information, working independently (individually or in small groups), using equipment and materials, observing purposefully and drawing appropriate conclusions based on these findings.
 4. The student will demonstrate competency in the use of the processes of science by: (a) observing, (b) classifying, (c) communicating, (d) measuring, (e) inferring, (f) formulating hypotheses, (g) interpreting data, (h) controlling variables and (i) experimenting.
 5. The student will construct quantitative and qualitative records that can be used as evidence for reaching tentative conclusions.
 6. The student will accept and modify ideas, and defend a point of view by making use of supporting evidence.
 7. The student will discriminate between evidence and proof, fact and theory, observation and inference, summation and analysis.
 8. The student will demonstrate his competency with textbooks or reference books using the table of contents, the index and the glossary to obtain information.
 9. The student will pursue problems for study and state the methods for gaining the solutions to these problems.
 - *10. The student will demonstrate a desire to learn and a curiosity for the unknown by formulating and performing self-motivated investigations.
 11. The student will explain basic conceptual schemes of the material world using personal experiences acquired through various activities as the basis for his explanation.
 - *12. The student will identify examples of scientific hypotheses and theories as evidence that man's interpretation of the truth changes as his knowledge increases.
- * These aims are more appropriate for intermediate children than primary.

TEACHING STRATEGIES

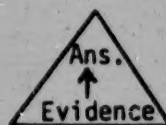
Each Televised Program

Utilizes one or more of these techniques.

When they occur, they are identified by a key symbol in the Teacher's Guide to student-teacher-TV interaction.



- 1 Teacher questions require students to arrive at an answer by examining and manipulating the materials they are using.



- 2 Responses are accepted when students use evidence from their lesson activities in observing and responding.



- 3 Student interpretations are considered acceptable, even though often they are partial or temporary conclusions, so long as the evidence and materials of the lesson support the responses.



- 4 Reasonable time is provided during discussion for observation, thought and reflection.



- 5 Teacher questions and behaviors emphasize the use of the SFTS processes including observing, classifying, communicating, measuring, inferring and predicting.



- 6 Teacher questions encourage wider student thought and suggestions for additional investigative behavior.

↗ Ideas
Materials
↖ Ideas

1. Teacher questions and statements require students to examine and manipulate the materials they are using to arrive at their answers.

SFTS IS COMMITTED TO DIRECT EXPERIENCE, ACTIVITY CENTERED LEARNING IN SCIENCE.

Most of the science ideas that young children can conceptualize are those within the limits of direct experiences. The children's interactions with simple materials provide the source of their beginning knowledge and, in most cases, should define the limits of their knowledge. It is usually inappropriate to ask young children to generalize beyond the scope of their experiences, to formulate abstractions, or to accept abstractions.

The learning in SFTS lessons involves student interaction with materials as a means of generating both questions and answers.

THE IDEAS (ANSWERS) OFTEN LEAD TO FURTHER ACTIVITIES IN AN EFFORT TO SEEK SUPPORTIVE OR MODIFYING EVIDENCE.

WE SHOULD ENCOURAGE PRIMARY GRADE CHILDREN TO IDENTIFY AND PURSUE THE KINDS OF QUESTIONS THAT THEY WILL BE ABLE TO ANSWER BY "DOING SOMETHING" WITH "THINGS".

WE, AS TEACHERS, MUST ASK THE TYPES OF QUESTIONS YOUNG CHILDREN CAN ANSWER BY DIRECT OBSERVATIONS OF THINGS OR BY HOW THINGS INTERACT.

THE ABOVE THREE POINTS IMPLY:

- A. "WHY" QUESTIONS ARE RARELY APPROPRIATE TO USE WITH YOUNG CHILDREN
- B. TEACHERS MUST FREQUENTLY RESTATE QUESTIONS ASKED BY CHILDREN SO THAT THE QUESTIONS ARE IN A FORM WHICH LEADS THEM BACK TO OBSERVING AND INTERACTING WITH MATERIALS.

Enabling

Tom, what did you do that was different from what Jean did? There must be a good reason for the different results you got.

Why don't you both do it again to find out what caused your different observations?

When you turn the big wheel once, what does the little wheel do?

What might you do with your mystery box to try to find out how many objects are in it?

(Child - Why doesn't my siphon work?)

Watch me do it a few times to see if you can find out what you were doing that is different.

Ginny, you said the salt feels like sand. Could your hand lens help you find out more about the shape of salt and sand grains?

(Child - Why does the water drop roll around this piece of waxed paper and on the glass?)

Why don't you try some other materials to find out how drops act on them?

Jimmie says he is sure there is a rock in this mystery box. Let's list all our observations and see if they all fit Jimmie's conclusion.

Child - I think the salt is way up on the side of the jar because somebody must have shaken it.

Teacher - That could explain it - How could we find out if shaking caused it?

Inhibiting

Tom, you probably didn't leave the thermometer in the water long enough.

Jimmie got the right answer. Andy, you must have done something wrong.

Can you see how the big wheel is used to increase speed?

How many objects do you think the box contains?

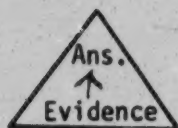
You didn't get all the air out of the tube. Hold one end at the bottom of the jar and the other near the top.

That's right, they both have sharp corners.

Because glass has a stronger attraction for water than waxed paper does.

It can't be a rock, Jimmie, because I didn't put any rocks in the boxes.

No - nobody shook it. That's not the reason.



2. Teacher fosters student support of their inferences by leading them to establish a direct relationship between their ideas and the observational evidence on which they are based.

SCIENCE KNOWLEDGE IS BUILT FROM AND UPON WHAT IS KNOWN.

Science investigation is a process of seeking evidence, i.e., that which can be known. To this end, we must continually encourage children to give concrete evidence to support an inference, statement of fact, or conclusion. Observations represent what we know. Inferences are tentative explanations, predictions or conclusions which fit our limited knowledge.

Instead of "wild guesses", children should be encouraged to make "educated guesses" based on what they know to be true, i.e., evidence.

The wise teacher avoids making authoritarian decisions as to whose ideas are right. In an investigation-centered science experience, children who make statements which are in conflict with the ideas of the teacher, the book, or other children can often be at least equally right. Differences in explanations may be due to differences in observations, amount of evidence available, communication skills, etc.

When children are challenged to produce the evidence to support a statement interesting outcomes may result, i.e.:

- A. They may revise their statement.
- B. They may justify their "different" interpretation.
- C. They may recognize a need to repeat their original activity.
- D. They may identify a careless observation.
- E. They gain insight into the interdependency between observations and inferences.

Enabling

What did you observe that made you say that?

Show us what you did and what you observed that gave you that idea.

Try doing it again to check your observations.

Do you have a reason for saying that?

What is your evidence for making that guess (prediction, etc.)?

Do we need more evidence before we can say that?

Inhibiting

No, that's wrong (or that's right).

Children, I have a box here. What do you think is in the box?

This experiment proves that air is everywhere.

Rejecting (or accepting) an idea without giving children a chance to present their evidence.

Allowing children to argue a point without using observations or other appropriate evidence to defend their point of view.

Accepting or inflicting abstract verbalizations for which children have no experiential foundation.

Approval

3. Student interpretations are considered acceptable (even though they are partial or temporary conclusions) as long as the evidence from their investigations and experiences support their responses.

SCIENCE IS SELF CORRECTING. THAT IS: ANY EXPLANATIONS (EVEN THOSE OF SCIENTISTS) ARE TENTATIVE AND SUBJECT TO CHANGE AS NEW EVIDENCE IS ACQUIRED.

Science knowledge is dynamic. Whenever scientists encounter new evidence, they reexamine related theories, conclusions, etc. The new evidence may cause them to strengthen, revise, or reject existing ideas.

So, too, with young children. Their science concepts evolve through a sequence of partial truths - those that are true within the limits of their experience.

Each of us can only be as right as our observations, past experience and reasoning power permit us to be. As long as we regard our ideas as dynamic - i.e. subject to modification when conflicting new evidence is encountered - knowledge evolves in a pattern that is meaningful, that reflects openmindedness, and which is in keeping with the spirit of science.

At the primary level, the child's explanations may fit his limited evidence and experience yet not be in agreement with ideas of the "experts". Any child's idea, justified by his evidence should be accepted without condescension or qualifying statements such as "but..." or "however...", etc. Teacher Responses can reflect the idea of tentativeness by taking such form as:

That seems to explain what we now know.
Does that fit all we have observed?
Is there anything else we can do to check our idea?

EXAMPLESEnabling

Child - Magnets attract only nails and paper clips, nothing else.

Teacher - That agrees with our observations.

Child - The dripping water goes down the drain into the ground.

Teacher - (No comment)

(Perhaps arrange for children to visit a house under construction and revise this idea).

Child - There are two marbles in the box because (state relevant observations).

Teacher, "You have found some real good clues". (Later when children compare, three clicks may be demonstrated).

Observation and Description

Lesson

Child - I think the answer is the aquarium.

Teacher - That fits all the clues I gave you, doesn't it. But it isn't the object I have in mind. I guess you need another characteristic. The object would fit in your desk.

The candle in the jar went out because it didn't have enough air.

Teacher, accept with approval.

Inhibiting

Yes, magnets attract all iron and steel.

No, it goes through pipes to the septic tank.

You didn't observe very carefully. If you had you would have heard three objects bump against the side.

No, that's not the object I have in mind. Guess again.

The real reason it went out was it didn't have enough oxygen (oxygen is merely a meaningless verbalization for young children).



4. Reasonable time is provided during discussion for observation, thought, and reflection.

BY INCREASING "WAIT-TIME" AFTER DISCUSSION QUESTIONS TO FIVE SECONDS, TEACHERS HAVE FOUND THAT MORE CHILDREN PARTICIPATE, THE QUALITY OF RESPONSES INCREASE, AND GREATER PUPIL TO PUPIL DISCUSSION OCCURS.

This practice involves what Mary Budd Rowe has titled "wait-time". Her research indicates that many teachers seem unable to tolerate periods of silence longer than one second during class discussion. If children are barraged with questions and pressured for immediate answers, they do not have time to involve themselves in the mental, observational and manipulative activities which are important to an investigative type science program.

Young children need time to think, to figure out, and to reconcile conflicting ideas. They need time to derive answers from observations. They need time to communicate their ideas. Discussion among children improves their communication skills. School is a place where children evolve their learning, not where they recite "right" answers.

Try to wait at least five seconds before calling on a child for a verbal contribution. Wait again, after the child's statement, to give the children in the group time to think about what has been said and to react with questions, additional information, statement of conflicting ideas, etc.

By increasing "wait-time" the talk pattern in a classroom often changes from:

Teacher-pupil-teacher-pupil, etc.

to

Teacher-pupil-pupil-pupil-teacher-pupil-pupil-teacher, etc.

Teachers might find statements similar to the following helpful in fostering effective use of wait-time.

1. I'm not going to call on anyone for a while so that each of you has a chance to think of what you want to say.
2. Think about it and raise your hand when you have an idea. I'll nod and you can put your hand down until others are ready with ideas.
3. I'll tilt the mystery box slowly several times so you can really hear the sounds and think about what they help you to know.
4. Think about what Johnny said and decide why you agree or why you disagree with him.

Process

5. Teacher questions and behaviors emphasize the use of SFTS processes including observing, classifying, communicating, measuring, inferring, and predicting.

THE DEVELOPMENT OF SKILLS IN USING THE PROCESSES OF SCIENCE IS BASIC TO PRODUCTIVE INVESTIGATION IN SCIENCE.

The processes listed here are selected from those identified in the SFTS AIMS as being most appropriate for children in the primary grades.

OBSERVING

Looking
Listening
Feeling
Smelling
Tasting

CLASSIFYING

Identifying
likenesses
Identifying
differences
Grouping into
Sets

COMMUNICATING

Verbally
By Gesture
By Showing
By Drawing
By Diagrams
Listening
Questioning

MEASURING

Size
Weight
Quantity
(volume)
Number

INFERRING

Using obser-
vations and
past experien-
ces to construct
tentative expla-
nations, conclu-
sions, predic-
tions, etc.

PREDICTING

(Extrapolating)
Inferring a be-
havior by imagin-
ing an extension
of a pattern which
has been identified
(by graph, table,
list, etc.)

These process skills are useful in curriculum areas other than science. Many teachers report that their first and second graders gradually transfer these skills to use in subjects other than science. The process skills are important in one's role as a consumer, as a citizen, in interacting with people, etc.

Example: Discriminating between inferences and observations.

Primary grade teachers realize that children's ideas often exceed their ability to express them verbally. Because of this limitation, young children should be encouraged to use gestures, to demonstrate (with the actual materials) what they did, and to use other appropriate methods to convey their thoughts and their questions to classmates and to the teacher.

To help children grow intellectually and to grow in self-image, teachers are challenged to use all their ingenuity to:

- a. convey to the child that both teacher and classmates are sincerely eager to understand what the child means;
- b. avoid inferring, prematurely, the idea the child is trying to convey.

Sample teacher statements that support communication skill growth:

1. Tell us a little more about it
2. Show us what you mean
3. Would it help us to understand if you make a drawing on the chalkboard?
4. Try to say it another way
5. Jimmy, you look confused. Can you ask a question to help us explain this better for you?
6. Jane, tell us in your own words what you think Anne means. That will help Anne find out if she has gotten her idea across.
7. I'm going to say it in another way and you can see if I understand what you mean.

Open
Ended

6. Teacher questions and statements encourage wider student thought and suggestions for additional investigative behavior.

OBSERVATIONS AND CHILD-CENTERED DISCUSSIONS INVARIABLY LEAD TO QUESTIONS.

Investigation type science learning is often divergent since it focuses on what children find meaningful and what children ask about their observations. Some of the questions which arise can be directly answered by further investigation.

However, we should not let children feel that they can find or understand answers to all their questions. Let's face it, they can't. Some questions may need to be modified to divert the child's interest into something which can profitably be investigated by doing something.

When children report conflicting (or seemingly conflicting) outcomes to investigations, the conflict can usually be resolved best by going back to the materials to identify the source of disagreement, e.g.: inaccurate observation, variations in procedure, legitimate differences in interpretation, etc.

Often a common class investigation leads to suggestions from the children or teacher for further investigation. These can provide opportunity for individuals or small groups to do further work at home or at school.

Open ended elementary science provides for:

- a. closure on child's terms
- b. creativity and divergence
- c. individual differences

Examples of teacher reactions which support strategy #6:

1. Try it and see what happens.
2. Can you think of anything you can do to find out?
3. Child: "Why does it do that?"
Teacher: "What did you have to do to make it happen?"

4. Child: "I have a drop inside my drop" (referring to air bubble in water drop).
Teacher: "Why don't you see if you can figure out what causes that."
5. Child: "Drops are round like circles"
Teacher: "Would you like to try some other liquids like soap and oil to see if they make round drops?"
6. Child: "I don't think the water in the sink goes into the ground. I think there's a sewer where all the water goes."
Teacher: "Perhaps you can ask your parents more about that and tell us what you find out."

27/28

ITV LESSONS

INVESTIGATING DROPS

Television Introduction

Teacher Orientation

During this lesson the children watch a girl as she notices drops in her outdoor environment. Then she moves indoors and does some of the kinds of things with water drops which children will be doing in the follow-up activities in the SFTS lesson. The televised lesson is primarily designed to stimulate curiosity and interest and to demonstrate some techniques for studying the way drops interact with surfaces and with each other.

There are three places during the program where the narration stimulates class response. No signal is used to indicate these, but the accompanying guide sheet identifies them for you. In addition, relevant spontaneous comments by the children at other times during the lesson should not be discouraged.

During the follow-up SFTS lesson activities, encourage the children to be creative in their investigations, to describe their observations of drop characteristics, and to identify likenesses and differences resulting from interaction of drops on different surfaces. Accept and encourage creative use of descriptive, childlike words to help children communicate their ideas.

This lesson is an excellent readiness investigation for the study of cohesion and adhesion which children will encounter at higher grade levels.

SFTS/ITV: INVESTIGATING DROPS (color)				Teaching Strategy
Discussion Period and Time	TV Image	Final Broadcast Statement	Suggested Statements or Questions	
1 30 sec.	Closeup of drop of water	How would you describe it to someone?	How many things do you notice about the drop?...How else can you describe the drop?	1 
2 30 sec.	A large drop and a small drop	In what ways would you say they are the same and in what ways are they different?	What do you see that is the same about all drops? What differences do you see?	1 
3 approx. 5 to 6 minutes	The girl begins a diverse series of manipulation of drops	See how many other things you can discover about drops.	Watch carefully and tell us all the different things you can learn about drops. NOTE: You will be interacting with children for several minutes as you discuss their observations on the TV screen. Possible observations: You might stimulate children's responses by raising questions about: 1-Ways of moving the drop. 2-Breaking a drop into smaller drops. 3-Combining drops into larger drops. 4-What happens when you blow on a drop? 5-Ways drops vary when placed on different materials. 6-Variation in way drops run down different sloping surfaces.	5  Observation and Communication 1  4 

Title: Investigating Drops - Dr. Dorothy Alfke

Level: Primary

Aims: From SFTS Toward Which this Lesson Contributes

1. The student will solve problems by gathering information, working independently, using equipment and materials, observing purposefully and drawing appropriate conclusions based on these findings.
2. The student will explain basic conceptual schemes of the material world using personal experiences acquired through various activities as the basis for explanation.
3. The student will demonstrate competency in the use of the processes of science by (a) observing, and (b) classifying.
4. The student will defend a point of view by making use of supporting evidence.

Instructional Objectives: At the conclusion of this lesson, the students will be able to:

Make at least one prediction about the behavior of water drops on the kinds of surfaces they have studied.

Background Information:

This activity is presented as a guided investigation in which children are to state freely observations and inferences on their own terms. The informal playing around with drops of water on various surfaces will lead to verbal comments by some children and the beginning of mental concepts for others. The teacher can stimulate children to try to describe interactions while circulating during the investigation. The teacher can also be alert to identify certain activities and statements which might later be shared with the class. "Right" answers are those which make sense to children as they investigate and observe. If the teacher tries out activities in advance and tries to observe and manipulate drops as a child might, the teacher will be better prepared to guide this investigation.

Total equipment list for a class of 30 pupils.

- 8 small jars of water
- 9 medicine droppers, short straws or other devices for forming water drops
- 30 pencils or other bluntly pointed objects
- 30 straws for each day (may be saved from milk time)
roll of waxed paper
- 60 pieces of smooth finish paper and spares
small container of oil (i.e.: salad oil, mineral oil, baby oil)
- 8 crayons

8 pieces of chalk

large piece of firm cardboard (at least 10" X 20") or cookie sheet
roll of aluminum foil

30 3X5 cards (desirable, but smooth surface paper can be substituted plastic, glass, metal, or other kinds of surfaces.

Activity I

Materials for each group of four children:

small jar of water

dropper

4 sheets of waxed paper

4 straws

4 pencils or bluntly pointed objects

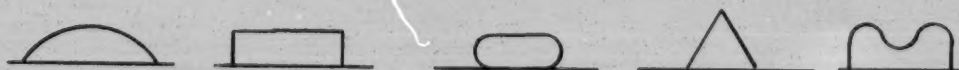
Place a small jar of water with a medicine dropper or short straw, on each table of four children. Give each child a piece of waxed paper.

Have the children place about three drops of water at different places on their waxed paper. Ask for observations of the drops. It will probably be necessary to initiate such questions as the following:

"What can you notice about the shape of the drop?"

"Is the drop bigger around at the paper or above the paper?" or

"What do you notice about the shape of the drop when you look at it from the side?" (You might make the following drawings on the board and ask children to decide which looks most like a side view of the drop.)



Tell the children to use the pointed end of a pencil to play around with the drops and encourage comments on the things they find they can or cannot do with the drops.

Consider the following questions during the investigation:

Can you make the three drops into one drop?

Can you move the drops wherever you want to?

Can you make several small drops out of one big drop?

What differences can you notice between a big drop and a small drop?

What can you find about a big drop and a little drop that is the same?

How small a drop can you make?

Give each child a straw and suggest that they use them to blow on the drops. Encourage comments.

Activity II

Materials for each group of four students:

- 4 3X5 cards or pieces of paper
- small jar of water
- dropper
- 4 pencils (or substitute)
- 4 straws
- set of assorted surfaces (i.e.: aluminum foil, construction paper, plastic, glass, metal pan, etc.)

Give each child a 3X5 card and have the students investigate the interaction between the water drops and the paper as they did when they used the wax paper. Solicit observations as in Activity I.

Be sure each child has a fresh drop on a fresh part of the surface of the waxed paper and of the card. Use the same type of questions listed for Activity I. Solicit comparative observations such as:

"Can you find any differences between the drop on the waxed paper and the drop on the card?"

"Where is it easier to make small drops from a big drop - on the waxed paper or on the card?"

"Is it easier to move a drop around on the waxed paper or on the card?"

etc.

Distribute assorted surfaces to each group stating that they may try to find out how water drops interact with any of the surfaces.

Activity III

Materials for each group of four students:

- 4 pieces of paper
- small jar of water
- dropper
- 4 straws
- 4 pieces of chalk
- 4 wax crayons

For the teacher:

- a dropper
- small jar of oil (salad oil, olive oil, baby oil)

Give each child a piece of clean white paper. Have them draw lines to divide their paper into four roughly equal parts. Then instruct them to cover one section with crayon markings and another section with chalk. While they are doing this, put one or two drops of oil on a clean section of each child's paper and tell them to rub it with their finger to make a grease spot.

Have the children drop several drops of water on the four different surfaces and compare the interaction of the drops of water with the surfaces.

Discuss the children's observations.

Activity IV - Competency measure

Materials:

Cookie sheet
large cardboard or other rigid surface (at least 20" X 10")
3" X 8" strips of plain paper
waxed paper
aluminum foil
oil rubbed paper
chalk coated paper
water and dropper
cellophane or masking tape

Tape strips (at least 3 inches by 8 inches) of each of the following side by side on a large sheet of cardboard:

plain white paper
waxed paper
aluminum foil
oil rubbed paper
chalk coated paper

Lay the above on a table or on the floor so that all the children can see it.

Place a fair sized drop (less than size of a dime) of water on two different surfaces near one end. Explain to the children that you are going to raise the end of the cardboard where the drops were placed to make a sloping surface. Ask the children to predict the order in which the drops will move down the slope with reasons for their predictions.

Tilt the cardboard and have the children observe the "drop race." Repeat this demonstration several times using different pairs of surfaces each time. Encourage the children to comment on their observations and their explanations for the behavior of the drops. When appropriate, try to have children relate this activity to previous experiences in this lesson. Then place a drop on each of the five surfaces taped to the cardboard and have the children predict the order in which the drops will move to the bottom of the "track." Tilt the board and have the children test their predictions.

Additional Activities

Repeat the lesson activities using one or two other kinds of liquid drops. Additional examples might include oil, alcohol, vinegar, milk, molasses, etc.

INVESTIGATING MYSTERY BOXES

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread the lesson activities over several days. Emphasis in this television presentation will be placed upon introducing basic processes and techniques leading to student instructional objectives as well as teaching strategies that you may use to promote these desired objectives.

The lesson centers around a gift-wrapped package which the viewers are asked to observe and make inferences as to its contents. Many of the early questions are the kind which are best answered by statements such as "We don't know" since no evidence for inferences is provided. Then the lesson suggests some ways that children can make observations to gather evidence to provide clues for inferring the contents of the box. Some emphasis is placed on developing vocabulary for communicating observations.

The SFTS lesson follow-up activities focus on observations and inferences. Teachers will find phrases such as the following to be helpful:

"What did you observe which made you think that?"

"What else might you do to check your idea (or inference)?"

"What could you do with your box to find out?"

"Is there anything you can think to do to try to find out which idea fits best?"

"It seems as if both inferences could be right until we can think of some new way to get more clues."

On ten occasions during this television introduction, questions are posed and time is provided for discussion in the classroom. The following charts suggest teacher reactions and teaching strategies that may be employed during the discussion period.

Discussion Period and Time	TV Image	SFTS/ITV: INVESTIGATING MYSTERY BOXES (black and white)		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
1 1 minute	?	What ideas do you have about what you would do to discover what is in the mystery box?	Without opening the box, how would you decide what is in the box?	6 
2 30 sec.	?	How big do you think this box is?	What do you see that might help you tell how big it is?	3 
3 30 sec.	?	How heavy do you think it is?	What do you know that weighs about that much?	3 
4 35 sec.	Child holds box next to various objects	What words would you use to tell about its size?	Watch for several seconds and tell us what you discover about the size of the box.	4 
5 45 sec.	Child compares weight of mystery box with other boxes	What words would you use to tell how heavy you think it is?	Watch to see what you discover about the weight of the boxes.	2 
6 35 sec.	Child shaking the mystery box	What words will you use to describe the sounds you hear?	Can you think of anything you know that might make a sound like that?	5  Communication

Discussion Period and Time	TV Image	SFTS/ITV: INVESTIGATING MYSTERY BOXES		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
7 25 sec.	Child shaking mystery box	By listening to the sound, can you tell how many things are in our mystery box?	Listen closely for sound clues. How many things would you say are in the box?	3 
8 25 sec.	Child slowly tilting the box	What does it tell you about something in the box?	The child is tilting the box slowly. Listen for several clues before you answer.	4 
9 25 sec.	Child tilting mystery box	What do these sounds tell you about what's in the box?	What do you believe is in the box? Why did you make that choice?	2 
10 3 sec.	Child looking at mystery box	Can you think of any other way that we might learn about what's in the package?	The boy is puzzled, isn't he? Could you help him to think of any other way to solve our mystery?	6 
11 30 sec.	?	...name some of the things that you could smell if they were in our mystery box.	What could we put in the box that someone would know by their smell?	5  Communication

Activity No. 17

Title: Investigating Mystery Boxes - Dr. Dorothy Alfke

Level: Primary

Aims: From SFTS Towards Which This Lesson Contributes

1. The student will solve problems by gathering information, working independently, observing purposefully and drawing appropriate conclusions based on these findings.
2. The student will identify examples of scientific hypotheses and theories as evidence that man's interpretation of truth changes as his knowledge increases.
3. The student will demonstrate competency in the use of the processes of science by: (a) observing, (b) classifying, (c) communicating, (d) inferring, (e) formulating hypotheses.
4. The student will discriminate between evidence and proof, fact and theory, observation and inference.
5. The student will defend a point of view by making use of supporting evidence.

Instructional Objectives:

At the conclusion of this lesson the student will state at least two observations to justify an inferred identification of an object concealed in a closed box.

Background Information:

This set of activities is designed to help develop skill and appreciation for the important use of indirect evidence in drawing and supporting inferences. Therefore, approval should be given when children communicate an observation they make with their senses rather than for a lucky or superficial "correct" guess as to the unseen object. Emphasis on more observations to strengthen or reject an inference about an unseen object should be encouraged as long as a possibility of more useful clues seems to exist. The teacher should encourage and respect contradictory inferences which are supported by observations.

In other words, being "right" in this lesson means producing supporting observations. Thus, children could infer different objects for the same mystery box and still be equally right.

Objects listed should be viewed as helpful suggestions. Alternative items could be substituted according to what is most easily available. Items chosen, however, should be the kind that produce some clearly identifiable clues by indirect observation as well as some common clues (example: balls and cylinders both roll but cylinders roll only along one surface. A short sliding sound usually indicates the object is longer than an object which has a long sliding sound).

Often a good supply of shoeboxes will be donated by a shoe store owner. It is not necessary to have all the boxes the same, but it helps in making some comparative observations. Teachers can usually obtain a sufficient supply of boxes by soliciting help from friends and pupils.

Boxes can be identified for discussion and reference in various ways. Assorted colored stripes may be added with paints or crayons. Pictures of animals might be pasted to the boxes. Numbers or letters might be used to add to the learning or review function of the lesson.

List of Equipment for a Class of 30 Pupils

22 shoeboxes or assorted sturdy boxes

scotch or masking tape

sets of objects (suggested list)

For Activity #3

4 ping pong balls

4 golf balls

4 like wooden or plastic blocks

4 plastic or metal jar lids

4 like bars or scented soap

4 like bean bags

2 pencil or pen

2 like rubber balls

2 like rubber toys (i.e., mice or dolls)

1 pair socks

Some Suggestions for Alternate Objects

empty cylindrical can (juice, vegetable, etc.)

small onions with a slash to release odor

string of beads or pieces of metal chain

balls of clay

Investigating Mystery Boxes

Activity I

Materials: 1 set of the 6 objects to be used in Activity 3

Arrange children in a semicircle around a table. Place the set of assorted objects on the table and ask the children to describe in as many ways as they can the objects and their characteristics. Discuss each object in turn. Then choose objects in pairs or in groups of three and

solicit additional characteristics to differentiate between the objects. Guide the discussion to characteristics which might be useful in the later activities such as:

- "the balls roll"
- "the golf ball is heavier than the ping pong ball"
- "the soap smells"
- "the bean bag squishes"
- "the lid slides when its one way and rolls when its another"

Activity II

Materials: 2 boxes, tape (scotch or masking), pencil or pen, small extra roll of scotch tape

Take two identical shoe boxes and put the pencil in one and the scotch tape in the other while the children are watching. Tape each box so that the lid is secure. Switch the boxes behind your back several times so that the children cannot associate a box and its contents.

Give one box to one child and the other to another. Instruct them not to squeeze the boxes, but tell them they can move them in any way they want to help them decide which object they think is in their box. After one or two minutes have each child pass his box to another child. Continue the passing along of the boxes as many times as seems appropriate in terms of effective use of time.

Then have children discuss their ideas about what is in each box. Whenever possible, ask children to state the observations which they felt were good clues.

Try to encourage other children to listen and watch for clues.

Discuss clues only as they relate to inferences about an object. Avoid comments or facial expressions that support or reject student observations or inferences.

Encourage children to demonstrate anything they did which yielded a helpful clue. Allow one or two other children to do what was demonstrated and see if they feel the same way.

When the teacher's judgement dictates, open the boxes so children can check their inferences. Then repeat any observations which yielded productive clues, such as:

- a rolling sound versus sliding sound
- a long slide versus a short slide
- a difference in weight
- etc.

Activity III

Materials: 18 boxes scotch tape
 4 ping pong balls 4 jar lids
 4 golf balls 4 bars of soap
 4 blocks 4 bean bags
 or alternative sets of objects

Prepare a complete set of boxes in advance of this lesson. Use the objects which were studied in Activity One, placing one object in a box and taping the box closed. Each box should have an identifying number or other symbol (A letter or colored geometric shape marked on the box are other possible markings). Prepare enough boxes so that there is at least one for each two children. This means that there will be duplicates. Keep the scented soap boxes separate from the rest until the boxes are distributed to the children so that the scent doesn't spread to other boxes.

Arrange children in pairs. Give one box to each pair, after discussing with them that they are to try to find out enough about what's in the box to infer (figure out) what the object is inside. Caution them not to crush or open the boxes.

As you circulate, stimulate productive observations, i.e., slowly tilting box, listening for sounds as box is manipulated, smelling, hefting for some sense of how heavy.

Have children bring the box to you to tell you what they think is in their box and why. Check to see if they have made some productive observations. Record their decision for future references and give them a new box to work with.

When most children have worked with about three boxes, collect all the boxes and gather the class into a semicircle to discuss their decisions. When each box has been discussed, open the box and show what was in it.

NOTE: It might be interesting to have an extra set of objects and an extra box on hand during the discussion before the children's boxes are opened. Thus, some conflicting inferences might be checked by placing each of the suspected objects, in turn, in the extra box to see if it produces the same evidence the children had observed. This is a simple example of constructing a model in science.

Activity IV - Competency

Materials: 2 boxes, 2 rubber balls, 2 rubber toy figures,
 1 pair of socks

Place a rubber ball, a rubber toy figure, and a rolled up sock on a table in the room. On the same table place a red colored sealed box containing another rolled up sock and a blue colored sealed box containing a rubber ball. Explain that the children are to go to the table during free time and manipulate the boxes to decide which of the

three objects they think is in each of the boxes. Remind them that they will be asked to give reasons for their inferences.

Either have children report their decision to you when they are ready or have a class discussion when all children have had a chance to investigate the boxes. Always insist that any inference about the unseen object be supported by observations providing clues.

INVESTIGATING OBSERVATION AND DESCRIPTION

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread the SFTS lesson activities over several days. Emphasis in this television presentation will be placed on introducing basic concepts and techniques leading to student instructional objectives as well as techniques that you may use to promote these desired objectives.

This program was televised in the classroom where children interact with the teacher and the environment as they play the child's game "I Spy With My Little Eye." Much of the televised program is centered around objects shaped like a doughnut. The program requires no science equipment. Attention is directed to the use of the senses in determining the characteristics of an object and the development of vocabulary for describing these as a useful tool for expression. Emphasis is also directed to the fact that a few descriptive words about one object may well accurately describe a large number of objects. Therefore, with only a few descriptive clues, a large number of speculations relative to what object is described may be accurate. Still another major area of importance is the warning that one must be careful in using his senses to observe his surroundings. Poisons, bright lights, loud noises, and noxious fumes can all be damaging to the body. The classroom teacher is urged to constantly alert children to the dangers of touching, tasting, and smelling unknown materials.

The science concepts for which this SFTS lesson serves as a readiness experience are: shape, weight, the senses, characteristics, and safety. On six occasions during this television introduction, questions are posed and time provided for discussion in the classroom. The charts on the next page indicate the length of the discussion period questions raised and suggested strategies which may be followed.

Discussion Period and Time	TV Image	SFIS/ITV: INVESTIGATING OBSERVATION & DESCRIPTION (black & white)		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
1 30 sec.	Hand holding doughnut	Can you name another object in your classroom that's about the same size as this doughnut?	Let's take a few seconds and look around the room. Can you think of anything you know that might be about the same size as the doughnuts?...Is it bigger or smaller than your hand? A plate? etc.	4 
2 30 sec.	Hand holding doughnut	What could you tell someone to help him know how heavy it is?	What do you see around you that would be heavier than the doughnut? Lighter than doughnut?	5  Inference
3 30 sec.	Hand feeling doughnut	For example, what do you know about how a doughnut would feel if you touched it?	Think of the doughnuts you have had. What words would you use to tell us how a doughnut feels?	3 
4 30 sec.	Child smelling, tasting doughnut	What words would you use to describe its taste and its odor?	Have you eaten doughnuts recently? How would you describe the smell or taste of the doughnut (on TV)?	3 
5 30 sec.	Doughnut on plate	OK, can you think of any other characteristics that you would use to describe a doughnut?	How else would you describe a doughnut? Can you think of any characteristic we might have missed? Can you bend a doughnut?	6 

Discussion Period and Time	TV Image	SFTS/ITV: INVESTIGATING OBSERVATION AND DESCRIPTION		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
6 1 minute 30 sec.	Two flowers in a vase	Suppose you take a few minutes and list everything you can about it.	How many things could you see that would help us describe the flower?	5 Process Observation & Communication

Title: Investigating Observation and Description (Dr. Duane R. Smith)

Level: Primary

Aims: From SFTS Toward Which This Lesson Contributes

1. The student will demonstrate competency in the use of the processes of science by: (a) observing, (b) classifying, (c) communicating, (d) measuring, (e) recording, (f) interpreting data.
2. The student will defend his point of view by making use of supporting evidence.

Instructional Objectives - At the conclusion of this lesson, the students will be able to:

1. Make descriptive statements about the physical characteristics of an object which they select.
2. Use a wide range of descriptive statements based on an expanded awareness of the role of their senses in observation.
3. Classify the descriptive statements used by themselves and others according to the sense which was used as a base for the descriptive statement.

Background Information

The basic assumption underlying this series of lessons is that primary (and intermediate) grade students vary greatly in their ability to observe, describe and communicate their perceptions of objects or persons in their environment. These lessons begin simply, using objects from the child's own personal environment, and extend to less familiar objects in his expanded environment. In a similar manner, the students earliest descriptive statements are accepted as the base level of verbal operation and from that point he is encouraged to use a greater number of his senses to sharpen the descriptive statements which he formulates. In addition, these lessons are able to help each student begin to approach the tasks of observation, description and communication in a more systematic way. This entire description is

conducted at the verbal level. Records are completed by the teacher with assistance from the students.

The basic technical information is directly related to the five senses. These lessons should encourage students to utilize to a fuller extent all of the senses they have available.

This series of lessons is designed to be used over an extended period of time. The time will vary according to the interest of the class. The suggested activities can be initiated as a group but may be extended into individual student activity or into student science activity centers.

There are no special materials required. This is not a seasonal exercise. It is appropriate at any time and the type of lesson that benefits from repetition.

Total Equipment List

1. Objects students select from their own personal environment.
2. Someplace for the student to hide his "secret" object. (i.e. in his pocket, in an envelope, in his desk, etc.)
3. Chalkboard and chalk, or Newsprint and felt pen or crayon.

Activity I - Readiness Survey

Materials needed: pupils

Ask each child to quietly and secretly select an object from his desk or from his own personal possessions. Ask that each child think about the item he has chosen and decide just how he will describe the characteristics of his object to the others in the class without naming the object or describing how it is used.

Arrange the students in a circle and begin the process of description. The purpose here is to have the students describe the characteristics

related to size, weight, shape, color, construction, smell, feel or taste adequately in the class so that the children can identify the object.

After several children have described their object and have permitted the total group to observe the objects, direct the children's attention to the kinds of descriptive statements that students have been making. Select those statements which are most useful in identifying the object.

Discuss which senses the children have used to describe the object. List on the board or on newsprint those senses which the children identify. If all five senses are not identified, encourage further discussion to complete the list.

see hear smell feel taste (or similar words which identify the five senses)

Tally the senses which each child has used in his descriptive statements.

This may do two things: first, it may encourage a wider range or sensory based statements, and secondly, it will provide a tally to show just which of the senses the class uses most frequently in describing an object....and thereby indicates which senses we will want to explore to sharpen our powers of both observation and description.

This is also a form of classification, a fact that the class may be encouraged to discover. -(Let the
students dig it out for themselves -- then let them verbalize it for others in the class.)

This initial activity will provide an opportunity to have each member of the class respond. Make mental notes about the level of each child's response or jot down some coded information about each child's response to indicate the level at which he started this series of lessons.

Activity II

Materials needed: The pupils and the objects they selected in Activity I.

Using the same group of varied objects, ask the children to group the objects which have similar characteristics. This discussion may lead into the types of classification that they may want to try....it would be possible to group objects by their function (use), their construction, their weight, their color, etc. The selection or development of the categories should be established by the class.

Once the categories are established, each student may then place his object in a category. He must, however, have a reason for placing his object in a category. Other students in the group may raise questions or challenge the placement of any object as long as they have a valid reason. This may lead to a finer description of the basic categories.

In this lesson as in the previous one, there will be a variety of responses. Be aware of this fact and seek to permit each child his response. Encourage him at his level of operation. Learning experiences conducted in this way permit correct student responses which may not have been anticipated.

Competencies

The competencies stated in the instructional objectives can be checked and verified throughout the progress of the lesson. The skills developed in these activities are also important in reading, art, math, social studies and other areas of the curriculum. Therefore, it is assumed that you will encourage the use of these skills wherever they apply.

INVESTIGATING MEASUREMENT

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread the SFTS lesson activities over several days. Emphasis in this television presentation will be placed upon introducing basic concepts and techniques leading to student instructional objectives as well as techniques that you may use to promote these desired objectives.

The television presentation opens with scenes that illustrate size discrepancies - things that are too large and too small. From that point, attention is given to ways in which the appropriate size can be determined. Where discrepancies are large, they can be determined through direct examination. But, when size differences are very slight, they must be determined and compared through more careful measurement.

The program was televised in an urban environment and is centered around the measurement required for a group of children to complete a go-cart as well as the purchase of a pair of shoes for one of the girls.

The final scene of the televised program requires that the teacher be prepared with five strips of construction paper or cardboard 12 inches by 1 inch. If each of the pieces of paper was a different color, this would be helpful. The teacher should be prepared to place each strip of paper against the TV screen and cut to a prescribed length.

The science and mathematics concepts for which this SFTS lesson serves as a readiness experience are: large, small, and length. On five occasions during the television introduction, questions are posed and time provided for discussion in the classroom. The charts on the next page indicate the length of discussion periods, questions raised and suggested strategies which may be followed:

SEIS/IIIV: INVESTIGATING MEASUREMENT (black & white)		Suggested Statements or Questions		Teaching Strategy
Discussion Period and Time	TV Image	Final Broadcast Statement:		
1 (no break given)	Mother and daughter leaving house	In each case what do you think the problem is?	What did you see in the pictures that the people were having trouble with?...What else did you see happening?	2 
2 30 sec.	Girl's feet and three groups of shoes	...and which are about right?	Pick out the large ones...and the small ones...and the ones that are the right size.	1 
3 20 sec.	Girl's foot next to two shoes	Without trying them on. Can you think of any way you can check to see if they fit?	Can you think of any way of telling which shoes might fit this foot?...What else might you do to find out?	6 
4 Extended discussion period	Scenes of measurement	Watch closely and tell about what kind of measuring you see being done.	What do you think she (he) is measuring for?	2 
5 1 min.	Five strips of wood	Take a minute to find the longest and the shortest.	NOTE: The teacher should cut strips of paper the lengths of the shoes on the screen. Number the strips to correspond with the shoes. Ask students to arrange strips from shortest to longest.	5  Measurement

Title: Investigating Measurement - Dr. Roy Allison

Level: Intermediate

Aims: From SFTS Towards Which This Lesson Contributes

1. The student will measure with English units and metric units to solve problems concerning length.
2. The student will solve problems by gathering information, working independently, using equipment and materials, observing purposefully and drawing appropriate conclusions based on these findings.
3. The student will demonstrate a competency in the use of the process of science by: (a) observing, (b) communicating, (c) measuring, (d) inferring.

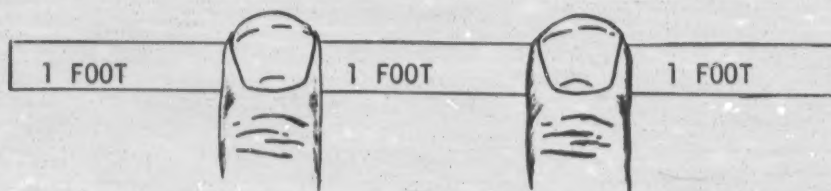
Instructional Objectives: At the conclusion of this lesson, the students will be able to:

1. measure lengths and widths of objects in the units given
2. communicate information to other classmates using the same units
3. identify reasons for standard units of measure
4. defend the selection of one measuring instrument rather than a larger or smaller one

Background Information

This set of activities is intended to promote a student discussion about the need for standard units of measure and basic techniques of properly measuring objects.

The first exercise brings out the difficulty of communicating information regarding the size of a familiar object if the measuring instruments are not of standard size. During this exercise, the teacher is to observe to see if the students are using accepted techniques in making their measurements. Some of the common errors are: (1) not accurately counting the number of times the measuring instruments are used, (2) not measuring in a direct straight line, such as along an edge if the object is a rectangle, (3) allowing the measuring instrument to slip while measuring and (4) not putting the measuring instrument down each time at the same spot it was lifted from just before



(this measure is often incorrectly recorded as 3 feet and not 3 feet 2 fingers).

The errors above and any others the teacher observes should be demonstrated without comment as activity II to allow students to discover some of their common errors of measurement.

The universal units of measure are those of the metric system. Only a small portion of the world's population still cling tenaciously to the English system of measure.

The fourth activity should teach the students that it is easier and probably more accurate when long distances are measured with the big measuring instruments, and that smaller objects are more easily measured with smaller measuring instruments.

Total Equipment List for a Class of 30 Pupils

10 foot rulers	10 3" sticks (popsicle)
10 yardsticks	10 4" sticks (popsicle)
10 metersticks	10 6" sticks (popsicle)
30 5" sticks (popsicle)	assorted objects to be measured

Activities: Each activity should occupy one class period of about 20 to 30 minutes.

Activity I - Readiness Survey

Materials: Popsicle sticks or dowels cut into at least three different lengths (example 3", 4", 6").

Provide each pupil with one and only one length of stick and ask him or her to measure the length and width of their desk and to record their answer. After each student has measured their desk, have the students use the same measuring instrument to measure their neighbor's desk. Record all measurements of each desk on the chalkboard as (10 sticks by 13 sticks for Mary B's Desk) these records are recorded; the students will find two sets of answers for the size of some of the desks.

Ask the class for some reasons why two students measuring the same desk did not get the same measurements. Did the desk change size? Didn't each student properly count the number of times they had to put the stick down? Did they measure properly? Were the sticks the same size?

Activity II - Demonstration

The teacher should demonstrate each of the errors in measurement observed in activity one without comment and then ask the class what was wrong with each demonstration and have the students discuss the error and make appropriate suggestions for ways to eliminate the error.

Activity III

Materials: a 5" stick for each pupil

Each student should now get the same size (length) stick and be asked again to measure two desks. Again record the results on the chalkboards and try to determine the degree of agreement each answer has with regard to the approximate class mean. Ask each pupil to write a letter to a friend communicating the size of his desk in the units used. Have the class discuss how these units could have meaning to someone outside this class. See if the class brings out the need for standard units to aid in communication of sizes to someone else outside the class. Ask the class what standard units could be used to have universal understanding.

Activity IV

Materials: for each group of three students, one ruler, one yardstick and one meter stick.

Assign each group the job of measuring the length and width of (1) the classroom, (2) a student's desk top, (3) the chalkboard and (4) several small items, such as notebook paper, etc. Ask them to record their results for each object measured and tell what measuring instrument they used to achieve these results. Ask them to defend the choice of instrument giving reasons for that choice.

Competencies

Give a small English ruler, small ruler and a yardstick, and have the students measure assorted objects selected by the teacher and report to the nearest whole unit (wooden blocks, desk top, a fellow student, a large cardboard box, etc.) based on an appropriate measuring instrument.

INVESTIGATING THE THERMOMETER

Television Introduction

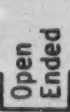
Teacher Orientation

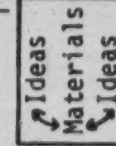
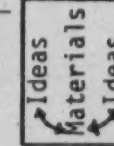
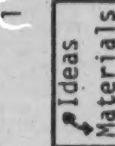
This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread the SFTS lesson activities over several days. Emphasis in this television presentation will be placed upon introducing basic concepts and techniques leading to student instructional objectives as well as techniques that you may use to promote these desired objectives.

This activity introduction is designed to introduce the child to the thermometer as a device for measuring temperature. Following a view of a number of different types of thermometers being used in a wide variety of settings, a typical thermometer is examined carefully. The parts of the thermometer are viewed closely followed by opportunities to see how temperature affects the liquid in a thermometer.

Much of the televised program is devoted to reading a thermometer (Fahrenheit). The children will be expected to read the numbers 10, 20, etc. to 80 as well as count by twos from 70 to 80. Although the follow-up SFTS lessons require some equipment, the televised program requires no equipment.

The science and mathematics concepts for which this SFTS lesson serves as a readiness experience are: numbers, measurement, heat energy, temperature, expansion and contraction. However these terms are not narrated in the televised program. On eleven occasions during this television program, questions are posed and time provided for discussion in the classroom. The charts on the next page indicate the length of the discussion period, questions raised and suggested strategies which may be followed.

Discussion Period and Time	TV Image	SFTS/ITV: INVESTIGATING THE THERMOMETER (prior)		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
1 30 sec.	Scenes of thermometer being used	These people all have something in common - can you tell what it is?	Can you describe what each person is doing?	3 
2 1 min.	Scenes of high and low temperatures and corresponding thermometer readings	Suppose you watch this thermometer in several different situations and tell what you see happening.	What is it like when the temperature is high? Low?	2 
3 30 sec.	Sun and Thermometer	Do you know how to use a thermometer to measure the temperature?	How would you use a thermometer? When have you seen thermometers used?	6 
4 14 sec.	Thermometer at 70°	Can you tell what the temperature is on this thermometer?	What number is nearest to the top of the liquid?	1 
5 15 sec.	Thermometer at 80°	Now, what is the temperature?	What number is nearest to the top of the liquid?	1 

Discussion Period and Time	TV Image	SFTS/IV: INVESTIGATING THE THERMOMETER		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
6 15 sec.	Thermometer at 74°	What do you think this temperature is?	What is the temperature now? Can you figure out what the temperature is now?	
7 20 sec.	Thermometer at 77°	So, what would you say the temperature is?	Count up from seventy until you get to the top of the liquid.	
8 15 sec.	Thermometer at 77° and drops to 72°	Suppose you watch the thermometer and see if you can read the temperature every time it changes.	Count up from seventy until you get to the top of the liquid.	
9 15 sec.	Thermometer at 72° and rises to 75°	How about this?	What would you say the temperature is?	
10 15 sec.	Thermometer at 75° and drops to 70°	Now, what is this temperature?	Can you tell me what the temperature is?	
11 15 sec.	Thermometer at 70° and rises to 76°	How about this temperature?	Can you tell me what the temperature is?	

Science Activity: Investigating the Thermometer
Dr. Robert Shrigley

Level: Lower Primary

Aims: (1) The student will solve problems by gathering information, working in groups, using equipment, observing purposefully and drawing appropriate conclusions based on these findings.

(2) The student will demonstrate competency in the use of processes of science by: (a) observing (b) measuring (c) interpreting data.

Instructional Objectives:

At the conclusion of this lesson, the children will be able to:

- (1) read and state verbally temperature readings.
- (2) match the readings of a model thermometer with a real thermometer.
- (3) identify temperature readings as higher or lower, greater than, less than.

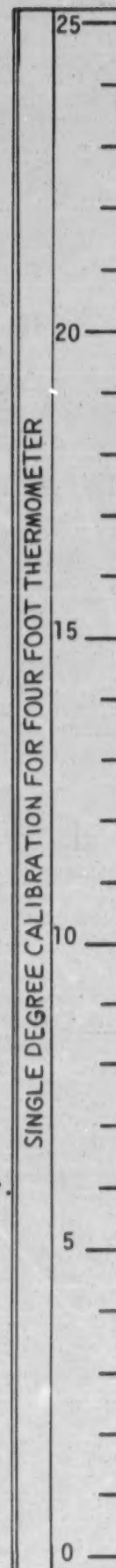
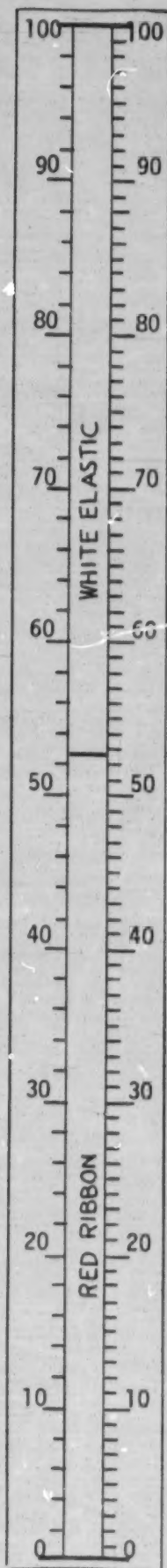
Background Information

A cardboard thermometer model about 4 feet tall is needed for this activity. If a slit is made at the 0° mark and 100° mark an endless belt made of red ribbon and white elastic (about one inch wide) can be threaded through the slits and sewed together. With some practice, children can learn to slide the red ribbon to any reading on the thermometer.

On the right side of the ribbon marks should be made for each degree 0 through 100 as shown at the left. On the left side of the ribbon, and in another color, the thermometer should be marked 0 through 100 in two degree calibrations. An illustration of the model thermometer is at left. On the right is the calibration of the degrees on a four-foot cardboard thermometer.

Equipment for class of thirty:

- 1 large cardboard thermometer
- 1 glass of cold tap water
- 1 glass of warm tap water
- A thermometer for each three or four students



Activity I - Readiness

Demonstrate the model thermometer to the children by moving the red ribbon to various locations on the scale simulating several temperature readings and ask individual students to read the temperatures. Start with easily read numbers such as 50°F, 60°F, 30°F, etc. Then 55°F, 35°F, 23°F, 61°F, etc.

Many children can be involved in this gamelike exercise if (1) one child calls out a temperature reading, (2) another child manipulates the model thermometer and (3) a third one checks the reading.

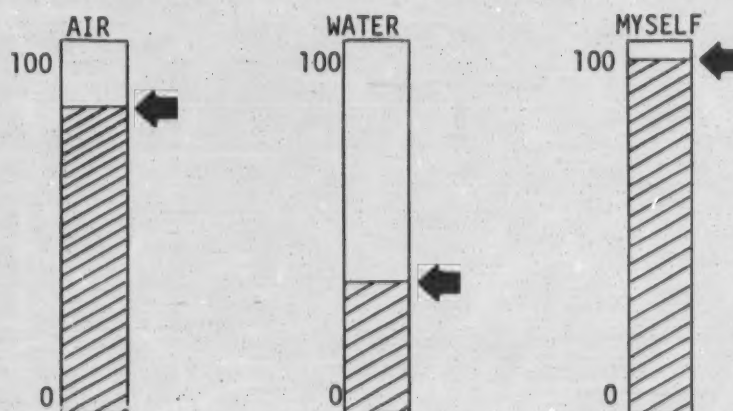
Activity II

Up to this point the children have read the side of the thermometer that has the readings calibrated in single degrees, (i.e., 0°, 1°, 2°, 3°, 4°, etc.).

Students will need some practice reading a number on the right side of thermometer (single degree) and then shifting to the left side for reading on a double degree scale. Begin with even numbers, 20°, 52°, 56°, 78°, 34°, etc. After some proficiency is gained with even numbers, try odd number readings.

Activity III

Stand the large cardboard thermometer in the chalk tray and make three vertical drawings similar in size to the ribbon on the thermometer:



Give three children a thermometer and ask one to (1) measure the temperature of the air in the room, (2) another the temperature of tap water and (3) a third child the temperature of his thumb. (He places his thumb gently on the bulb of the thermometer.)

Each child could be assisted by others who could (1) read the thermometer, (2) simulate the reading on the large model thermometer (3) mark the reading on each of the three chalkboard "thermometers." From the chalkboard bar graph, children could be asked to choose the highest and lowest reading. Some students might be asked to compute (and then count on the model thermometer) the difference between the readings.

Activity IV

1. Using the information collected on the temperature of air in the classroom, ask each child to estimate whether the temperature of the outside air is higher or lower than air inside the room.
2. The students should be divided into teams of three with following assignment:
 1. one student carries the thermometer
 2. one student reads the thermometer
 3. one student writes the outside temperature on a note pad
3. Upon return to the classroom, each team reports its reading of the outside temperature. Compare the outside and inside readings.

Activity V - Competency Measure

1. Complete a bulletin board bar graph with the temperature readings of the following phenomena in order from lowest to highest temperatures:
 1. outside air
 2. inside air
 3. myself
 4. tap water (cold)
 5. tap water (warm)
2. Ask the students to choose the highest and lowest temperatures. After scrambling the paper strips of the bulletin board bar graph, ask the students to choose again the highest and lowest readings.

INVESTIGATING EYES

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread the SFTS lesson activities over several days. Emphasis in this television presentation will be placed upon introducing basic concepts and techniques leading to student instructional objectives as well as techniques that you may use to promote these desired objectives.

Major areas of emphasis in the lesson include a recognition of ways in which our eyes serve us, the parts of the eye, some of the characteristic movements and properties of the eye, and the importance of protecting the eyes from harm.

During the televised lessons children are encouraged to perform some investigations with a partner. The partner teams can be organized prior to turning on the set.

In the following SFTS lesson activities, the teacher will probably need to guide the children to work in a deliberate manner in order to really observe the eye responses (i.e. "one" surprise "clap" to get a true blink).

Avoid the use of "Why" questions during discussions. In this lesson children are merely beginning to discover the wonder of the reactions of their eye as it makes adjustments to help them to see under various changing conditions.

On seven occasions during this television introduction, questions are posed and time is provided for discussion in the classroom. The following charts indicate the questions raised and suggested techniques which may be followed:

Discussion Period and Time	TV Image	SFIS/IV: INVESTIGATING EYES (black and white)		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
	Scenes in which children use their eyes	Watch carefully and describe all of the ways you see that your eyes help you.	How else do our eyes help us?	2 
1 25 sec.	Diagram of the eye	Suppose you take a moment and see how many parts you notice in this eye.	What different parts of the eye do you observe?	5  Communication
2 30 sec.	Moving finger in front of the eyes	What are your eyes doing to help you see your finger?	Watch carefully.	1 
3 45 sec.	Child moving finger with head and eyes still	After you've tried it on one side, try it on the other. Describe what happens.	Do what you see the child on TV doing.	1 
4 45 sec.	Finger moving in toward and out from the eyes	Describe <u>everything</u> that happens.	Move your finger in and out and tell us what you notice? Try it several times before you answer.	4 
5 45 sec.	Finger between eye and TV set	Do you have any ideas about <u>why</u> it happens?	What does the TV set look like when you are looking at your finger...and what does the finger look like when you are looking at the TV set?	1 

Discussion Period and Time	TV Image	SFIS/ITV: INVESTIGATING EYES		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
6 25 sec.	Hands clapping before face	Describe what the eyes do. Can you explain why?	Clap just once but wait a few seconds so your partner won't know just when you are going to do it.	1 
7 1 min.	Eye with pupil getting larger or smaller	Why do you think it is happening?	Do you think the light has any effect on the eye?	5  Inference

Activity No. 14

Title: Investigating Eyes - Dr. Dorothy Alfke

Level: Primary

Aims: From SFTS Toward Which this Lesson Contributes

1. The student will explain basic conceptual schemes of the material world using personal experiences acquired through various activities as the basis for his explanation.
2. The student will demonstrate competency in the use of the process of science by: (a) observing, (b) communicating, (c) inferring.

Instructional Objectives: At the conclusion of this lesson, the students will be able to:

1. Describe changes in the appearance of their eyes in response to various occurrences in the environment:
 - a. unexpected object flashing past eye
 - b. changes in direction of object to be looked at
 - c. changes in lighting

Background Information:

In this lesson children are given specific direction as to what to do. Experience with young children suggests that the teacher clearly demonstrate activities 3 and 4 to increase chances of productive observation and to insure safety. Young children usually need to be reminded that they won't be able to make observations unless they do as instructed. The activities are not open-ended, although all student comments, when based on observation, should be openly accepted. We are interested in "what children can find out" by observing as they carry out activities as opposed to "what they can repeat back to us" when we tell them.

The dark spot in the center of the eye is called the pupil. It is an opening surrounded by the colored ring called the iris. The iris adjusts to change the size of the pupil opening in response to the amount of light reaching the eyes. The pupil is smaller in bright light than in dim light.

The lens of the eye is located just behind the opening in the iris. An intricate system of muscles control the lens, the iris and other parts of the eye.

If children wear corrective lenses, the teacher must decide on an individual basis whether this lesson is inappropriate due to progress in student adjustment to the correction. Often, the lesson can be expanded to include an interesting discussion of children's glasses and how they help them see better.

Total equipment list for a class of 30 pupils

15 balls or bean bags - alternative -- one or two
 15 blindfolds - might use discs of cardboard with
 ribbons for tying on head
 large drawing of eye - optional
 doll or toy animal with some moving part to eyes

Activity I

Materials: for each two children - A ball or bean bag and blindfold

If most children are able to catch a ball or bean bag, do this as a class activity with children working in pairs. If not, do this as a class demonstration, using several "good catchers" in turn.

Have children stand an appropriate distance apart and toss a ball back and forth 20 times, keeping a record of successful catches versus unsuccessful catches. Then blindfold one child of each pair, covering one eye only, and again have pair toss 20 times, keeping a record. Have partners exchange blindfold and repeat.

Blindfold one eye of several children. Have them hold arms straight out to the side, with forefinger, only, extended. Then show them how they are to move their hands in an arc toward each other to touch their forefingers in front of them.

Repeat without the blindfold.

Most children will probably fail to bring fingers together with one eye blindfolded but will have no problem doing so with both eyes open.

Discuss the idea that two eyes help us do many things more successfully than we can do them with only one eye.

Activity II

Materials: optional - large drawing of an eye

Arrange children in groups of four. Explain that children are to work in pairs, looking at, not touching, each others eyes.

Then have each child look at the eyes of the three other children in the group. Have them decide how many likenesses and differences they can discover. Discuss all observations.

Activity III

Equipment - none

Have children work in pairs, taking turns with each other doing the activities listed below. Demonstrate each activity with one child first, cautioning children not to get close enough to his partner to touch him. For safety, have the students shield their eyes with clear plastic (overhead transparency).

1. Move a hand slowly past partner's face.
2. Move a hand rapidly past partner's face.
3. Clap hands in front of partner's face.
4. Throw a small wad of paper toward partner's eyes.

(Note - Do the above as demonstrations, using several children in turn, if you feel your children will not demonstrate enough safe behavior.

Have children discuss their ideas about how blinking might help protect eyes.

Then have children close their eyes and feel the hard bones above and below their eyes. Discuss how these help protect eyes.

Activity IV

Instruct partners to stare at each other trying not to blink. Tell children to raise their hands as soon as they see their partner blink.

Tell children to look at each other and try to open their eyes as wide as they can. Then close their eyes as much as they can and still see each other. Ask them to describe how eyelids change when they close their eyes, discussing how each eyelid (upper and lower) is involved.

Have children in turn, watch their partner's finger as:

- a. their partner moves his finger slowly to one side and then the other in front of them.
- b. he moves his finger downward and upward.

Discuss observations

Have one child of each pair sit in a chair with his partner behind him. Explain that the seated child must keep his head facing straight forward. Have partner hold his hand out to the side and slowly bring it around toward the front of the seated child. How far around must he bring his hand before the seated child can see it?

Activity V - Competency

Darken the classroom as much as possible. Have children, in pairs, look at the pupil in their partner's eyes.

Then turn the lights on in the room. What changes in the pupil of the eye did the children notice. Repeat this change from dark to bright light several times so children have adequate opportunity to observe the change in the size of pupil.

Activity VI - Competency

Obtain a doll or toy animal with some moveable part or parts to the eyes. Solicit comments from children on how the toy eyes are like their eyes and how they are different.

INVESTIGATING SALT AND WATER

Television Introduction

Teacher Orientation

This introduction to a series of activities dealing with salt and water is designed to provide a transition into the SFTS lesson which you will conduct following it. Emphasis will be placed upon introducing basic concepts and techniques leading to student instructional objectives as well as teaching strategies that you may use to promote these desired objectives.

The television presentation focuses upon identifying the characteristics of salt, water, and a solution of salt in water. At times, questions are asked which the viewer must speculate on for an answer. This is done purposely to arouse curiosity and stimulate motivation for the investigation that follows. Emphasis is placed on these procedural techniques - measuring a level teaspoon, and manipulating a magnifying glass - with which, experience has demonstrated, children require some guidance and direction.

On eight occasions during the television introduction, questions are posed and time provided for discussion in the classroom. The following charts on the next page indicate the questions raised and suggested techniques which may be followed:

Discussion Period and Time	TV Image	SFTS/ITV: INVESTIGATING SALT AND WATER (black & white)		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
1 30 sec.	Magnifying glass and salt granules	What do you suppose you can learn about salt by looking at it through a magnifying glass?	How does the salt look through the magnifying glass?	1 
2 30 sec.	Fingers feeling salt	From what you see, what would you say that salt feels like?	What words would you use to describe how salt feels?	5  Communication
3 25 sec.	Child smelling salt, granules of salt	Do you know if you can smell salt?	Does salt have an odor? How could you find out?	6 
4 25 sec.	Child tasting salt, granules of salt	What would you say that salt tastes like?	How does salt taste? What words would you use to describe the taste of salt?	5 

Title: Investigating Salt and Water - Dr. Dorothy Alfke

Level: Primary

Aims: From SFTS Toward Which This Lesson Contributes

1. The student will measure with English units to solve problems concerning volume.
2. The student will explain basic conceptual schemes of the material world using personal experiences acquired through various activities as the basis for his explanation.
3. The student will demonstrate competency in the use of the processes of science by (a) observing, (b) communicating, (c) measuring, (d) inferring.
4. The student will defend a point of view by making use of supporting evidence.

Instructional Objectives - At the conclusion of this lesson, the students will be able to:

1. Describe the appearance of a crystal of salt.
2. Describe the appearance of a solution of salt water.
3. Describe their perception of changes during dissolving and evaporation where salt and water are interacting.

Background Information

In this lesson children are investigating the processes of dissolving and crystallization. They prepare a saturated salt-water solution-that is- they add enough salt to the water to assure that the water dissolves as much salt as it is capable of dissolving at its present temperature. The surplus salt which the water cannot dissolve settles to the bottom as a clear, grainy sediment.

When evaporation occurs, only the water evaporates. As the amount of water decreases, some salt crystallizes out. The remainder is still saturated. Eventually, as all the water evaporates, the original amount of salt remains. The cubical shape characteristic of salt crystals can easily be recognized, sometimes without the aid of a hand lens. Crystals of this shape are usually found when they form from a salt solution. Other shapes often result from crowded conditions and various other factors.

The more slowly crystals form, the larger the crystals may be. Thus, as the water evaporates slowly from an open jar, one usually finds some easily recognized cubical crystals of salt. Because the crystals are colorless or white, they are sometimes better viewed on a background of dark construction paper.

The terms dissolve, solution, evaporate and crystal should be introduced in context. The children will vary in their acceptance of the terms for use in discussion. The terms should not be forced on them and their use should be alternated with the use of phrases expressing the ideas which the words represent.

Reading charts might be developed with each activity. This will permit children to keep records of observations and to make comparisons as changes occur.

Most table salts today have some additives to help them flow freely in damp weather. This could explain the cloudy appearance of the solution when it is first prepared. The additive eventually settles out and may appear as a cloudy sediment. Kosher salt or canning salt may have less of the additives. Rock salt does not usually have the cloudy additives but may have other impurities. These alternatives to regular table salt may be preferred and the non-salt components can be explained to the children if they comment on these as they make their observations.

Children will probably describe the salt crystal shape in many interesting ways. As they communicate their associative, imaginative descriptions, the teacher will have evidence of the skills of individual children in using the hand lens. In this activity we are interested in having children begin to appreciate that different kinds of crystals have a characteristic shape, and in having children increase in their ability to use a magnifying lens to extend their senses.

Plain tap water may leave a small amount of residue when it evaporates. One or two children might taste a bit of this. It will not be noticeably salty. This residue consists of other substances dissolved in the tap water and it is harmless. The dissolved substances vary with source and purification treatment of the water supply.

Often salt crystals develop on the jar above the surface of the water, sometimes even spreading over the edges of the jar. Some children comment on these and are satisfied to first make the observation. If others ask why it happens, it might be interesting to see what inferences they suggest. The explanation involves the concepts of cohesion and adhesion. Satisfying and appropriate teacher answers to "why" questions, as in this case, include some variations of the following:

"That's the peculiar thing about salt."

"That's the way salt, water and glass interact or behave together."

Total Equipment List for a Class of Thirty

masking tape to mark the level of 1/2 cup and to label jars and lids with student's names

16 jars or plastic containers with lids (capacity about 3/4 cups to 1-1 1/2 cups) marked with tape to indicate level of 1/2 cup water

15 small containers to hold about 7 teaspoons of salt
water

magnifying lenses (15 if possible) and/or microprojector

15 pieces of dark paper or other suitable background material

approximately 2 lbs. salt (table salt, Kosher salt, canning salt or rock salt)

Note: the last three are often sold in supermarkets.

Activity I

Materials Needed - All on list - prepare jars with tape marking level of approximately 1/2 cup water. Water may be added to jars before hand, or children can be given this task.

Give each team of two children a spoon, a dish of "white powder" (salt), and a marked jar containing 1/2 cup water.

Have the children taste the water and then taste the white powder, giving them opportunities to identify the two substances.

Demonstrate the process of measuring a level teaspoonful of the salt.

Explain that they are to add one level teaspoonful of salt to the water and stir with the spoon. Solicit observations. Have the children taste the solution. Introduce the term dissolving.

Repeat the procedure of adding one teaspoonful of salt at a time. Instruct them to stir until they no longer see evidence of salt on the bottom. After 5 or 6 teaspoonfuls have been added, some sparkling pieces of salt should settle out no matter how long the children stir. Encourage the children to continue stating observations.

Have the children put the lid on the jar and mark the jars with their names. Place the jars on a shelf or some place where they won't be disturbed.

Have the children study some dry salt grains with a hand lens or a microprojector. If hand lenses are used, a dark background will give a better view than a light background. Have the children describe the salt particles.

Activity II

Materials Needed - jars prepared in previous lesson, magnifying lenses

Distribute the jars of salt water to the children who prepared them. Make a special effort to avoid shaking them during distribution and observation. Have the children report and discuss observations.

Instruct the children to remove the lid and transfer about 1/2 teaspoonful of the salty water (solution) to the lid. Have them observe with magnifying lens.

Place the uncovered jars and matching lids (containing salt water) back at the undisturbed location.

Prepare a control jar of plain water and also add a few drops of plain water in a jar lid. Mark these and add them to the class collection.

Activity III

Materials: materials left from Activity II, hand lenses

On the following day, have the children take their jars and lids to their tables or desks to observe them. Distribute hand lenses. Have the children report their observations. Solicit their explanations of any changes which have occurred.

Activity IV

Materials: same as Activity III

Have the children observe their jars and lids of salt water as long as any changes are occurring. Where all the water has evaporated from the jars, have children scrape out some of the remaining "white stuff" and examine it with a hand lens.

If possible, try to collect all of the salt formed from one jar and measure it to see how many level teaspoonfuls there are. Discuss the comparison with the amount added when jars of salt water were prepared.

Activity V - Competency Measure

Materials: materials left from Activity IV

Give the children a few grains of the kind of salt they used when they started the investigation. Distribute hand lenses.

Ask for descriptions of the salt they started with and of the salt in their jars after evaporation. Are they alike in any ways? How are they different?

Instruct the children to add water to the level of the marker on their jar. As they stir to try to dissolve the salt, solicit descriptions of the changes taking place. (If all the salt does not dissolve easily, put the jars aside for a while and stir them again later.)

Have the children predict what will happen in their jars during the next few days.

During the following days continue to observe and discuss changes as long as they are noticeable.

Additional Activities

Have teams of interested children compare amounts of salt they can dissolve in:

- a. Equal amounts of hot water and cold water.
- b. Different amounts of water of the same temperature.
(1/2 cup, 1 cup, 3 cups)

INVESTIGATING SIPHONS

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. Emphasis will be placed upon introducing basic concepts and techniques leading to student instructional objectives as well as techniques that you may use to promote these desired objectives.

The entire television presentation is centered around the demonstration of a variety of circumstances under which a siphon will and will not operate. Children observing the television presentations are asked to watch carefully and try to pick out those procedures that are essential to the operation of a siphon and those factors that keep the siphon from working.

This television presentation probably places more responsibility in the hands of you, the classroom teacher, than any of the others. A strong emphasis is focused on the interaction between the classroom teacher, the children, and what is on the television set. Due to this constant interaction, the usual charts and procedures of assisting you during the television program are not appropriate.

During this television presentation, emphasis should be placed upon directing the attention of the children to what is happening on the television screen. While doing this, it would be good practice to consciously employ the six teaching techniques that are so vital to good elementary school science instruction. In doing so, it would be helpful to consciously structure questions, phrase remarks, and direct the children's attention in ways that are consistent with these techniques.

Teacher questions such as the following might be useful:

"Watch to see what he does differently this time."

"Where is he placing the ends of the tube?"

"What do you notice happening at the top part of the tube?"

"Did you observe something that might be a reason why it didn't work this time?"

"Watch to see what you notice that you didn't notice before."

(Siphons Continued)

The program attempts to introduce the idea that many cause and effect relationships are involved in the successful operation of a siphon. At the conclusion of the lesson it might be appropriate to solicit student comments as to what they think might be important when they try to make the water move through their siphons. Either of two approaches during this discussion might be appropriate:

- a. Make neutral responses to the ideas suggested by children so that they later confirm or reject their idea by working with their own siphon.
- b. Have siphoning equipment ready so that a child can show what he or she means and investigate his idea by "doing". Approval should be given for the procedure of "checking out" an idea by working with materials rather than for being "right". Positive reinforcement for modifying or rejecting an idea as a result of working with materials is most important in this type of investigative learning.

Level: Primary

Aims: From SFTS Toward Which This Lesson Contributes:

1. The student will demonstrate competency in the use of the processes of science by: (a) observing, (b) communicating and (c) inferring.
2. The student will defend a point of view by making use of supporting evidence.
3. The student will demonstrate a desire to learn and a curiosity for the unknown by formulating and performing self-motivated investigations.

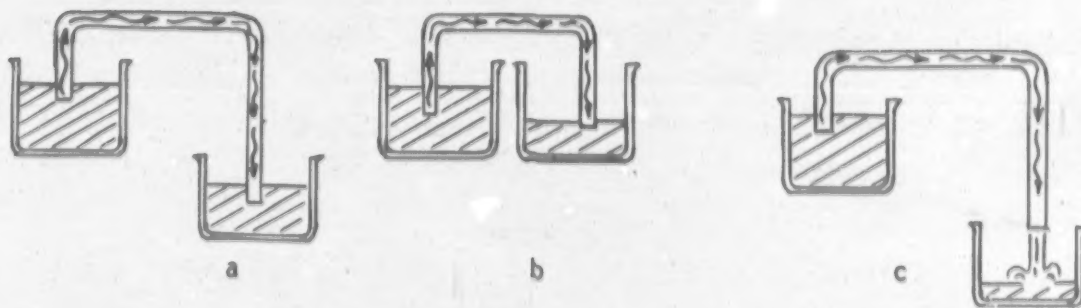
Instructional Objectives: At the conclusion of this lesson, the students will be able to:

1. Demonstrate the cause and effect relationships involved in the successful operation of a siphon.
2. Diagnose the difficulty when a siphon does not work.

Background Information:

A siphon is one device which is used to transfer a liquid from one place to another. A siphon may be a flexible tube or a rigid tube bent into a curved or square cornered shape (i.e., , , etc.) The important factors for successful operation of a siphon include:

1. The tube must be filled with liquid.
2. As the diagrams a, b, and c show below, the level of the liquid to be transferred must be (a) (b) higher than the level of the other container or (c) higher than the free end of the siphon tube.



The scientific principles involved in the operation of a siphon are not simple. For elementary school children, consideration of these principles is inappropriate. Children can learn cause and effect relationships involved in siphon operation and can investigate the effect of many variables. Those teachers interested in knowing more about the science of siphons can find information in general science and physics books.

Some people fill a siphon with the liquid by sucking the liquid into a tube. This is unsanitary, sometimes unpleasant, and in the case of certain liquids such as gasoline, potentially dangerous. A simple way to fill the tube with the liquid is to submerge it in the liquid, preferably with one end of the tube a little higher than the rest of the tube. (The experience of watching air bubbles come out as the liquid fills the tube is worth some discussion.) Then, holding a finger over each end of the tube (or if the tube is flexible, squeezing each end closed), transfer the tube, making sure one end is submerged in the higher liquid before removing fingers from the ends of the tubes. There are other filling methods which children can be expected to discover or invent.

This lesson is both literally and figuratively one of "messing about". Children should be encouraged to try any interesting ideas and variations which occur to them. The teacher must be willing to tolerate a fair amount of spilled water.

Total Equipment List for a class of 30 pupils:

Two buckets

piece of flexible tubing, about 2 feet long, preferably clear plastic

30 containers, about one quart size (two for each pair of children)

15 pieces of flexible tubing, preferably clear plastic, 10-12 inches long (one for each pair of children)

two-gallon jars

food coloring

mops or towels

Activity I

Readiness Survey - Demonstration

Materials: two buckets and a two-foot long piece of flexible tubing,
water

Demonstrate the transfer of water from one bucket to another using the tube as a siphon. Occasionally interrupt the flow of water by lifting the tube out of the higher level bucket. As you refill the tube to continue the transfer, focus the attention of the children on the tube filling process.

Permit the children to state any observations or inferences they wish. Do not give any indication of right or wrong. Suggesting instead that they see if they can get more evidence when they work with their own siphons.

Activity II

Materials: two containers, approximately one quart in size, and a
10-12 inch piece of flexible tubing for each pair of
children, water

Have the children try to work their own siphons. As they become skillful in filling tubes and making siphons work, encourage them to try out any variations they can invent. As you circulate, encourage the children to describe and demonstrate what they find.

Conduct a class discussion in which children summarize the things they have learned about siphons. Encourage the children to demonstrate their ideas as well as describe them verbally. Do not force any conclusions not initiated by the children. Accept any conclusions which students can defend with supporting evidence from the activity.

Activity III - Competency Measure

Materials: two gallon jars, flexible tube, about two feet long, food coloring, water

Arrange two gallon jars on a demonstration table. Fill one almost to the top with colored water. Fill a siphon tube with water and place it so that an end is in each jar. Allow the siphon to begin operating.

Have the children observe and describe their observations. When the action stops, ask the children for suggestions on how to get the flow started again. Try out all serious suggestions, letting the children analyze their effectiveness.

The following are some suggestions the children might make.

1. Add more water to either side.
2. Lift one jar higher than the other.
3. Pour water out of one jar.

Be sure that children experience ways of reversing the direction of flow.

INVESTIGATING THE DRIPPING FAUCET

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread the SFTS lesson activities over several days. Emphasis in this television presentation will be placed upon introducing basic concepts and techniques leading to student instructional objectives as well as techniques that you may use to promote these desired objectives.

The lesson centers around a dripping faucet. In addition to arousing a consciousness of the fact that water is a valuable resource and must be conserved, methods are used to involve viewers in science processes such as observing, communicating, measuring and interpreting data.

The televised program is initiated with a brief scene of a city water treatment plant. The narrator uses such words as "community", "purified", "water treatment" and "reservoir" so the teacher would be expected to use her own judgment in how she prepares the children for this vocabulary.

children are expected to count by ones to 50 and to write the numbers. Although the follow-up SFTS lessons require some equipment, the televised program requires no equipment.

The science concepts for which this SFTS lesson serves as a readiness experience are: water, conservation, time and gravity. However, these terms are not narrated in the televised program. On eight occasions during this television program, questions are posed and time provided for discussion in the classroom. The charts on the next page indicate the length of the discussion periods, questions raised and suggested strategies which may be followed:

Discussion Period and Time	TV Image	SFIS-ITV: INVESTIGATING THE DRIPPING FAUCET (color)		Teaching Strategy
		Final Broadcast Statement	Suggested Statements or Questions	
1 1 min.	Water dripping from faucet	Suppose you take a minute to talk about what you see happening.	What do you see?...Where do you think the water is going? Can you give use the reason for your answer?	6 
2 approx. 2 min.	Closeup of drain, then film showing	Take a few minutes to watch carefully and tell the ways you see water is being used.	Look closely at the TV and tell us what ways you see.	5  Observation & Communication
3 & 4 1 min. 1 min.	Dripping faucet and stop watch	Are you ready? Start counting.	(Count drops aloud with students.)	5  Measurement
5 30 sec.	A question-mark over both faucets	Which of these faucets wasted the most water and why?	What did you observe that helped you decide?	2 
6 approx. 3 min.	Closeup of two faucets, then film showing ways water is wasted	...tell other ways you see in which water is being wasted.	Watch closely. When is water running but not being used? When is he using water, and when is he wasting it?	2 

Title: Investigating Dripping Faucet - Dr. Robert L. Shrigley

Level: Lower Primary

- Aims:
1. Students will measure with English units to solve problems concerning volume and time.
 2. The students will work as a group to solve problems by gathering information, using materials, observing purposefully and drawing conclusions based on these findings.
 3. The students will demonstrate competency in use of processes of science by (a) observing (b) measuring (c) inferring (d) predicting.

Instructional

Objectives: At the conclusion of this lesson the students will be able to:

1. Describe verbally several uses they have for water.
2. Count the drops from a faucet.
3. Estimate, but with limited precision, the amount of water a faucet will drip in one hour.
4. Measure the amount of water dripped in one hour (one school day).
5. Measure and pour six "hour units" in a large container -- water wasted in one school day. (Upper primary grades)
6. Manipulate the hands of a handmade clock simulating 9:00, 10:00, 11:00, 12:00, 1:00, 2:00 and 3:00 at the same time that "hourly units" of water are poured into a large container. (Upper primary grades)
7. Dictate a story to the teacher describing accurately the science activity.

Background Information

Water allowed to drip from a faucet over a period of time amounts to a quantity of wasted water that is far greater than usually estimated by the young student. This experience can sensitize the student to the large quantity of water a dripping faucet can waste in one day.

The activity does require a faucet either in the classroom, school rest room, or outside the building. The teacher and students may need to spend some time adjusting the school faucet so that it drips in a regular fashion.

Activity IIIA is suggested for lower primary grades and Activity IIIB for the upper primary child. The alternatives are suggested because of the time element involved. Children who know the basic rudiments of telling time can handle Activity IIIB. Older primary children could complete both Activity IIIA and IIIB and compare their results.

Equipment

A classroom group will need: a faucet, a clock, a thimble (or small lid), a small baby food jar, a cup, a quart jar, an aquarium or four or five gallon plastic milk bottles, a funnel and a large rubber band (to mark water level).

If you choose to do Activity IIIA, you will need one large bucket. If you do Activity IIIB, each child will need a homemade clock face - perhaps a "paper plate clock" (a paper plate with a clock face drawn on it and moveable hands).

Activity I - Readiness

1. Younger children might be asked to cite verbally several uses they have for water. Wash hands. Brush teeth. Drink it. Swim in it.
2. Ask them to describe a dripping faucet (or spigot). Where does the water go? Is it wasted? If it is wasted, can they drink it? Brush their teeth with it?
3. How many of you have seen dripping faucets at home? Is the water wasted?

Activity II

1. Discuss with the children their concept of an hour. Two children's TV programs each a half hour long could equal an hour. A Disney TV program could be the equivalent of one hour. Three recess periods. The time period between lunch and music, etc. Ask the children to simulate one hour on the clock as one revolution of the minute hand on the classroom clock, or homemade clock faces made by children.
2. Ask them to estimate how much water a dripping faucet will waste in one hour. At the same time, hold up a thimble for children to see (or small lid), a baby food jar, a cup and a quart jar.
3. Print the following on the blackboard and tally the estimates of the whole class.
 - one thimble
 - one small baby food jar
 - one cup
 - one large (quart) jar
 - more than one large jar
4. Collect the water wasted by the dripping faucet in one hour and determine which group estimated most accurately.

Activity IIIA - (lower primary grades)

Place a bucket under the dripping faucet, when the school day begins, and collect the water wasted by the faucet from 9:00 to 3:00, one school day.

Activity IIIB - (upper primary grades)

Place a large container/aquarium, several gallon plastic milk bottles, etc.) on a table and prepare to pour in the large container the amount of water that is wasted in one school day.

Ask each child to place his clock hands on 9:00. As each child moves the hour hand around one whole turn and places the short hand on 10, ask one child to pour in the large container the water that dripped in one hour.

The container is placed under the faucet and filled (not dripped) to the one-hour mark. As each child simulates another hour on his clock, another "hour's worth" of water is poured into the large container.

This procedure is continued for 12:00, 1:00, 2:00 and 3:00 at which point children observe closely the amount of water a dripping faucet would waste in one school day.

Activity IV

Use the water wasted by the dripping faucet in one day to water school flowers, wash hands, replenish the aquarium. Record the use that was made of the water that would otherwise be wasted, i.e., 30 children's hands, 15 school plants, etc.

Activity V - Competency Measure

As the students in the group dictate orally the procedure and findings of their science activity, the teacher will print the class' composite story on the chalkboard or large sheet of paper. The students will be asked to check their story closely to see that it is accurate.

INVESTIGATING REFLECTION OF LIGHT BEAMS

Television Introduction

Teacher Orientation

This introduction is designed to provide a transition into the "science activities" which you will conduct following it. You will probably want to spread various sections of the SFTS lesson over several days.

This lesson is uniquely different from the others in the series. The viewer shares aesthetic and interesting observations of the interaction of light with materials in the urban environment of a young boy. It represents an experimental technique designed to suggest to viewers that there is much of simple beauty to enjoy in everyday things and there are many interesting phenomena to observe, wonder about, and to investigate.

Before viewing the film, explain to the class that they will be watching a program about light. Suggest that they try to discover things about how light behaves.

There is no narration or dialogue of any kind during the program. However, children should be told that they should feel free to make spontaneous comments about what they are observing about light.

The basic message of the televised lesson is light can be interesting to investigate. At the conclusion of this lesson, encourage children to express their observations and feelings related to the program. Then explain that they are going to investigate one part of the story of how light behaves: reflection. Start the SFTS lesson as soon after this discussion as possible.

Activity No. 16

Title: "Investigating Reflection of Light Beams" - Dr. Dorothy Alfke

Level: Primary

Aims: From SFTS Towards Which This Lesson Contributes

1. The students will solve problems by gathering information, working independently, using equipment and materials, observing purposefully, and drawing appropriate conclusions based on these findings.
2. The student will demonstrate competency in the use of the processes of science by (a) observing, (b) communicating, (c) inferring, (d) experimenting, (e) predicting.
3. The student will defend a point of view by making use of supporting evidence.

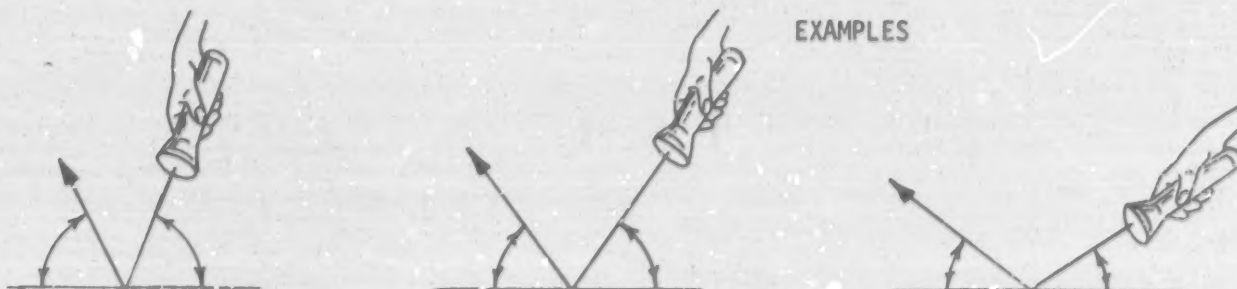
Instructional Objectives: At the conclusion of this lesson the students will be able to:

1. Direct a beam of light to a predetermined location by manipulating a mirror held in the path of the beam.
2. Communicate, in his own words/or drawings and gestures, a reasonable prediction of the path of a beam of light reflected by a mirror.

Background

In this lesson the children are engaged in exploratory experiences connected with reflection of light from a flat mirror. It is important to keep the investigations focused on the ideas the children develop and can explain in terms of their own observations. They should not be forced to accept any idea that they themselves do not suggest from their observations. In this lesson we are interested in having children grow in skills of observation, communication, and predicting, as well as in manipulative skills as they move the mirror to control light. Children will vary greatly in these skills as well as in their ability to conceptualize the ideas related to reflection.

Light is reflected from flat mirrors in a predictable pattern. The reflected beam makes the same size angle with the mirror surface as does the beam shining on the mirror.

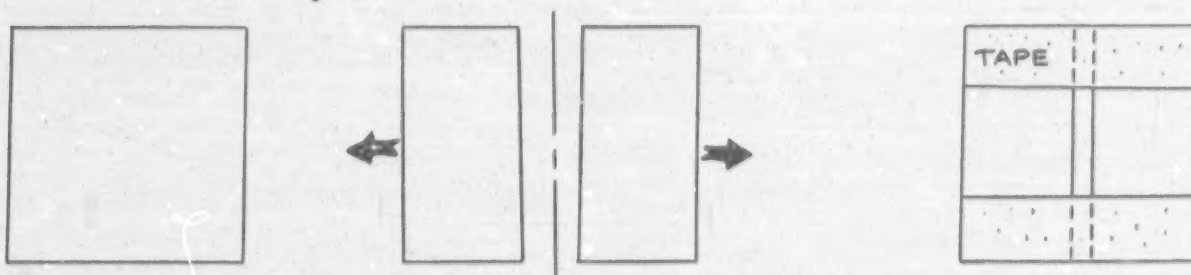


The teacher might use this lesson to serve the additional purposes of introducing or extending the concept of angles for children.

Background Information

When flashlights are used in these activities they should be at least of the two cell type so that they provide enough light for reflection to the corners and ceiling in the room.

A slide projector provides an excellent beam for demonstrations. The beam is improved if a "slit slide" is placed in the slide carrier. A slit slide is made by cutting a piece of cardboard to just the size of a 2x2 slide, which is then cut cleanly in half. The two halves are taped together to make a 2x2 slide with a tiny slit down the middle as in the diagram.



The "slit slide" can be placed in the slide carrier in either of two positions to produce either a horizontal or vertical beam. By focusing the lens, a very straight and clear beam is obtained to make the path of light very easy for children to see.

We cannot see light. We only see the objects which reflect light to our eyes. Unless there is dust in the air of the room, the path of the beam of light will not be visible in activity I. By adding water spray or chalk dust we introduce particles into the light beam which reflect light to our eyes. The children have had experiences related to this which the teacher might wish to discuss (i.e., auto headlights on clear versus rainy, foggy or snowy nights).

Note: In all activities, the children should not look at the projector lens. Students should stand in positions so that the mirrors are not used to reflect light into children's eyes.

Materials needed for a class of 30 children:

- 5-10 flashlights
- Slide projector (flashlight may be substituted)
- Piece of cardboard (about 8x11)
- Dusty chalkboard erasers
- Large cardboard carton
- Black or dark colored construction paper (2-4 sheets)
- 5-10 mirrors - rectangular, such as "purse type"

Activity I - Readiness Activity

Darken the room as much as possible. Shine a beam of light from a

slide projector or a flashlight. Have the children describe their observations with respect to the light beam. Some pertinent questions the teacher might use to stimulate and guide the discussion are:

What does the light beam help you to see?

Can you see anything between the projector (or flashlight) and the objects on which the light is shining?

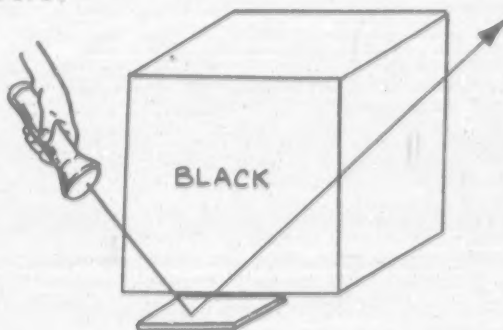
What can you do to find the light between the flashlight and the wall or other objects on which the light shines? (Examples: Hold hands in various places to find out where the light shines on them. Move a piece of cardboard from the light source to the wall trying to keep the light on the cardboard all the way. Shake the dusty chalkboard erasers between the light source and the lighted surface. Use a fine water spray from an atomizer or other types of spray bottle.)

Activity II

Materials: Large cardboard carton
Black or dark colored construction paper (to cover one side of box)
Flashlight
Mirror

Cover one side of a large cardboard carton with black (or dark colored) construction paper. Place the box on a table or desk with the dark side facing the class. Place a mirror on the desk so that one side touches the black side. Darken the room enough so that the flashlight beam can easily be seen.

Shine the flashlight beam at a slant so that the beam path shows on the black paper, strikes the mirror and is reflected along the black paper (see diagram). This should be tried in advance so that the teacher can get good light paths on the dark paper without too much trial and errors.



Have the children draw a diagram of the path of a beam of light before and after it reaches the mirror.

Change the slant of the beam and again have the children record their observations by drawing a diagram.

Then ask the children what they found out about how the light and the mirror interact. Encourage the children to communicate by words,

gestures, and chalkboard drawings. When disagreement or confusion occur, shine the light as before to enable the children to defend or modify their ideas, and to aid in communication among the children.

Activity III

Materials: Slide projector or flashlight
Mirror

Set up a slide projector or use a flashlight to produce a horizontal beam of light. Hold or place a mirror in the path of the light beam so that the light is reflected to the ceiling. Use chalk dust or some other method to help make the path of the beam visible.

Encourage a class discussion of observations of the path of the light beam.

Change the position of the mirror and again have the children discuss their observations. Repeat this as many times as interest and need justify.

Activity IV - Competency Measure

Materials: (for each group of 3-6 children)
Mirror
Flashlight

Demonstrate to the class the "game" they will be playing. Give a flashlight to one child and a mirror to another. Have a third clearly identify a spot where the light is to shine. Then ask the mirror-flashlight team to manipulate the light beam until they manage to shine the reflected beam on the designated spot. Give assistance and suggestions according to your judgment of need.

When the first team has succeeded, select a second team of three and repeat the activity, with a new spot selected.

Divide the class into groups, according to the number of flashlights and mirrors available (3-6 in a group is recommended). Establish a pattern of rotation and tasks within groups and have children proceed to manipulate the beams to direct reflected light to chosen spots.

As you circulate among groups, encourage the children to communicate their developing insight into reflected light through words and gestures. Each child should be able to reflect a light beam from a mirror to a predetermined spot and predict the path of the beam of light before turning on the light source.

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SFTS-ITV THEME SONG

Look! Looks like a globe.

Big bumps, funny humps, shiny spots, little dots -- and look!

I'll bet we can pick it apart.

Let's See!

The closer you get, the clearer it is, so look!

See the seal

Those humps are mountains, in cities are fountains,

Where kids,

Like us play around in the fizz.

Gee Whiz!

Let's go roaming in the fields.

Let's get to the playground and then nose around and see

Who's at school, there's John!

Picked a flower from the ground.

Smells nice!

It's not bitter sweet at all.

Arthur Goldstein